3D GeoModeller Reference

Parent topic: **User Manual and Tutorials**

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    - Mesh Grid Operations
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- Mesh and Grid Field Interpolation
  - Inverse Distance Interpolation
  - Variogram Analysis
  - Kriging
  - Domain Kriging
  - Sequential Gaussian Simulation (SGS)
- 3D GeoModeller Operations ('How to' instructions)
- Geoscientific Principles and Underpinnings
- Copyright and acknowledgments

Toolbar guide

- Project toolbar: See Project menu, Project toolbar and dialog boxes
- Section toolbar: See Section menu, toolbar and dialog boxes
- Structural toolbar: See 2D Structural sub menu and Structural toolbar
- Points List Editor toolbar: See Points List toolbar (docked)
- Model toolbar: See Model menu, toolbar and dialog boxes
- 2D Viewer toolbar: See 2D Viewer toolbar
- 3D Viewer toolbar: See 3D Controls sub menu and 3D Viewer toolbar

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Introduction to 3D GeoModeller, the geological editor

Parent topic: 3D GeoModeller Reference

Three dimensional modelling of the geology formations of the earth is an essential step towards effective understanding of complex geological phenomena.

In order to be relevant, such 3D modelling must be based not only on the whole of knowledge and the data available for the study area (maps, sections, terrain models, drillholes, etc.) but also on geological interpretation.

3D GeoModeller was designed to assemble together into the same 3D space data from various sources, in order to ensure geometrical coherence. To make this easier, 3D GeoModeller enables the geologist to work with familiar geological tools such as maps, sections and drillholes. Moreover, it provides the geologist-interpreter with the tools needed to impose their geological interpretation.

One of the innovations of 3D GeoModeller is the construction of geology interpolation which take into account not only the geology 'boundary' data (geology contacts, or interfaces or limits), but also incorporates the dip of the geology formations.

After computing the model, 3D GeoModeller can present it on a (geology) map, in cross-sections or as 3D shapes (volumes) defined by triangulated surfaces.

The development of a geometrical model is an essential first step for a wide range of later calculations. For example, a constrained and coherent model is essential for calculating volumes, conducting hydro-geologic simulations, calculating geophysical (gravimetric and magnetic) signatures, and for many other applications.

With 3D GeoModeller you can build a coherent 3D model which respects your data. Furthermore, its data-interchange abilities enable you to exchange data and results with other applications.

For more information about the architecture of 3D GeoModeller projects, see the Elements of a 3D GeoModeller project.

For more information about the 3D GeoModeller user interface, see User interface overview. To assist you in your use of the software, note that most of 3D GeoModeller's dialog boxes include a help button.

To get started with 3D GeoModeller, see 3D GeoModeller Tutorials and Help—Introduction. The tutorials use simple but practical examples, which lead you through the essential stages in the development of a 3D model.

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Elements of a 3D GeoModeller project

Parent topic: 3D GeoModeller Reference

In this section:

- The project
- The topographic surface
- Geology objects—formations, faults, axial series and surfaces
- The stratigraphic pile
- Sections
- Drillholes
- Structural data
  - Geology data
  - Geology orientation data (dip and dip direction)
  - Axial surface orientation data
  - Axial surface data (axial traces)
  - Hinge lines
- The 3D model

The project

Parent topic: Elements of a 3D GeoModeller project

The project is a set of data representing 3D space. It contains a structure, which gathers together the elements of your study.

Project properties

The project properties include descriptive data, location, limits and parameters. For a detailed description see Project Properties dialog box.

Project data that you import or create:

- Topographic surface
- Sections
- Formations, series and the stratigraphic pile
- Axial series (families), surfaces
- Geology contact and orientation data points
- Drillholes

3D GeoModeller shows all project components in the tree-structured **Project Explorer** list.

Project storage

3D GeoModeller stores projects in XML format.

3D GeoModeller stores all components in a folder. The main file of the project has the same name as the folder and a `.xml` extension.

Project operations

All project operations appear in the **File** menu and the commonly used ones in the **Project** toolbar. See:

- Project menu, Project toolbar and dialog boxes (user interface reference)
- Project and file operations ('How to ...' instructions)

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The topographic surface

Parent topic: Elements of a 3D GeoModeller project

In 3D GeoModeller there are two ways to generate a 3D topographic surface for the project:

- From a digital terrain model (DTM) in a variety of available grid formats (See Load Topography from a DTM dialog box)
- By using a horizontal plane, located at a specified height in the project model space (See Define Topography as an Horizontal Plane dialog box)

For the properties of the topographic surface, see Topography Properties dialog box.

To perform topographic surface operations use the **Project Explorer** or options in the **Section** menu. See:

- Section menu, toolbar and dialog boxes (user interface reference)
- Project Explorer—Sections shortcut menus (user interface reference)
- Topography and section operations ('How to ...' instructions)

Geology objects—formations, faults, axial series and surfaces

Parent topic: Elements of a 3D GeoModeller project

3D GeoModeller models contain three types of geology object:

- Geology formation (which belongs to a geology series, which in turn belongs to the stratigraphic pile)
- Fault
- Axial surface (which belongs to an axial series (family)

When you create a geology object in 3D GeoModeller, you specify:

- Properties that 3D GeoModeller uses, including name and colour
- *(Formations)* The series to which it belongs (You can create series and associate formations after you create them)
- *(Axial surfaces)* The axial series to which it belongs (You need to create the axial series before the axial surface)
- Other information for your own use that 3D GeoModeller doesn't use

Before 3D GeoModeller can work with a formation, fault or axial surface, you need to associate geology data with it. For an axial surface you also need to create a section from it.

To perform formation and fault operations use the **Project Explorer** or options in the **Geology** menu. See:

- Geology menu and dialog boxes (user interface reference)
- Project Explorer—Formations shortcut menus (user interface reference)
- Geology formations and series operations ('How to ...' instructions)

To perform axial series and surface operations use the **Project Explorer** or options in the **Geology** menu. See:

- Geology menu and dialog boxes (user interface reference)
- Project Explorer—Sections shortcut menus (user interface reference)
- Structural data operations ('How to ...' instructions)

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The stratigraphic pile

Parent topic: Elements of a 3D GeoModeller project

The stratigraphic pile defines the sequential order of geology formations or events. This 'order of events' makes it possible to manage the relations between the geology formations in the computation (and interrogation) of 3D model. In a sedimentary terrain, it defines the chronology of the stratigraphic sequence.

The stratigraphic pile is sub-divided into series. Each series comprises one or more geology formations. 3D GeoModeller interpolates geology formations of any given series so that they remain generally parallel.

You can define the relationship of each series with 'older' series as 'on-lapping' or 'erosional' (cross-cutting). This is an important 'switch', which controls the nature of the contact between the formations when interrogating the model and generating model outputs such as model geology on maps and in sections.

The **Reference (Top or Bottom)** of the pile tells 3D GeoModeller whether the structural data contained in the map, sections and drillholes represent the **top contacts** or the **basal contacts** of the formations with which they are associated.

To perform series and stratigraphic pile operations use the **Project Explorer** or options in the **Geology** menu. See:

- Geology menu and dialog boxes (user interface reference)
- Project Explorer—Formations shortcut menus (user interface reference)
- Geology formations and series operations ('How to ...' instructions)

Sections

Parent topic: Elements of a 3D GeoModeller project

3D GeoModeller uses sections to define geology. It considers the topographic surface, which contains the geological map, a special instance of a section.

When you are building a 3D model of geological formations, you typically create sections and define or interpret the geology within those section views.

It is easy to create sections in 3D GeoModeller. You can:

- Use points you have clicked and recorded in the **Points List** (Creating a section from its trace)
- Define horizontal sections at a specified depth.

To perform section operations use the **Project Explorer** or options in the **Section** menu or toolbar. See:

- Section menu, toolbar and dialog boxes (user interface reference)
- Project Explorer—Sections shortcut menus (user interface reference)
- Topography and section operations ('How to ...' instructions)

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Drillholes

Parent topic: Elements of a 3D GeoModeller project

Drillhole functions in 3D GeoModeller are summarised below.

Drillhole operations are available in the **Import** menu, the **Project Explorer** tree (**Formations** and **Drillholes)** and from the **Model** menu or toolbar (**Project Data onto Sections in the 2D Viewer**). See:

- Importing drillholes and drillhole geophysical logs and assays
- Project Explorer and 2D Viewer—Drillholes shortcut menus (user interface reference)
- Model menu, toolbar and dialog boxes (user interface reference—visualising)
  - Model operations ('How to ...' instructions—visualising)
- Project Explorer—Formations shortcut menus (user interface reference—drillholes associated with formations)

Structural data

Parent topic: Elements of a 3D GeoModeller project

3D GeoModeller uses five distinct types of geology (structural) data. You can view these in the **2D Viewer**.

Structural data type	Associated with
Geology data contact points	Formation or fault
Geology orientation data (dip and dip direction)	Formation or fault
Axial surface data (axial traces)	Axial surface *(describing folds)*
Axial surface orientation data	Axial series *(describing folds)*
Hinge line data	Formation *(describing folds)*

3D GeoModeller uses all of these elements when it computes the 3D model.

3D GeoModeller regards faults, formations, axial surfaces and series as objects in the model which may have structural data attached to them. For more information about these, see Geology objects—formations, faults, axial series and surfaces.

You can input these data interactively in the **2D Viewer** or import them into your project.

3D GeoModeller displays each data point in the colour of the geology formation, fault or axial surface with which it is associated.

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To perform structural data operations use options in the **Import** menu (importing) and **Structural** menu or toolbar (creating and editing). See:

- Import menu and dialog boxes (user interface reference—importing)
- Points List (user interface reference—creating in **2D Viewer**)
- Geology menu and dialog boxes (user interface reference—creating and editing)
- Structural data operations ('How to ...' instructions—importing)
- Structural data operations ('How to ...' instructions—creating and editing)

In this section—types of object

- Geology data
- Geology orientation data (dip and dip direction)
- Axial surface data (axial traces)
- Axial surface orientation data
- Hinge lines

Geology data

A geology data point represents a point on a geology 'surface' such as an interface (contact) or fault. It has the following parameters:

- The (u, v) coordinates of the point (For an explanation of (u, v) see Status bar and conventions for spatial coordinates)
- The name of the geology formation on whose surface the points lies

  The properties of the stratigraphic pile determine whether the points are on the top of the formation or the bottom. See Create or Edit Geology Series and the Stratigraphic Pile dialog box
- (Optionally) associated geology orientation data

For more information about properties see Create (or Edit) Geology Data dialog box.

Geology orientation data (dip and dip direction)

A geology orientation data point represents the dip and dip direction of a geology surface at that point. It has the following parameters:

- The dip direction and the dip (using Hoek's convention—the line of maximum slope)
- The (u, v) coordinates of the point (For an explanation of (u, v) see Status bar and conventions for spatial coordinates)
- The polarity (normal or reverse) (See Overturned geology)
- The geology formation with which this data point is associated

For more information about properties see Create (or Edit) Geology Orientation Data dialog box.

You need to input geology orientation data one point at a time.

For more information about properties see Create (or Edit) Geology Orientation Data dialog box.

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Axial surface data (axial traces)

An axial surface data point (or point on an axial trace) defines the surface of symmetry of a fold. It has the following parameters:

- The (u, v) coordinates of the point (For an explanation of (u, v) see Status bar and conventions for spatial coordinates)
- The name of the axial surface

For more information about properties and conversion to a section, see:

- Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box.
- Create a Section from an Axial Surface dialog box

Axial surface orientation data

An axial surface orientation data point is the dip and dip direction of an axial surface (locally, an axial plane), and is used to represent the direction (or elongation) of a fold structure in a 3D GeoModeller project. It has the following parameters:

- The dip and dip direction (using Hoek's convention—the line of maximum slope)
- The (u, v) coordinates of the point (For an explanation of (u, v) see Status bar and conventions for spatial coordinates)
- The polarity (See Overturned geology)
- The plunge
- The associated axial series

  Note that axial surface orientation data is associated with an axial series, not a single axial surface, since it indicates the orientation of the fold structure

You need to input axial surface orientation data one point at a time.

For more information about properties see Create (or Edit) Axial Surface Orientation Data dialog box.

Hinge lines

A hinge line is a line intersecting an axial surface and a geology horizon (geology contact or interface). It represents the trace of the points of maximum curvature of a layer affected by a fold.

Create hinge lines within sections created from axial surface.

Hinge lines have the following parameters:

- A set of points, each having (u, v) coordinates (For an explanation of (u, v) see Status bar and conventions for spatial coordinates)
- The geology formation intersecting the axial surface section
- Parameters specifying the aperture and distance
- Polarity (left or right)

For more information about properties see Create (or Edit) Hinge Line Data dialog box.

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The 3D model

Parent topic: Elements of a 3D GeoModeller project

3D GeoModeller uses the geology and structural data recorded on the map (topography), in sections and in drillholes to compute a 3D model of the geology. It also must use the information recorded in the stratigraphic pile for the project.

The model is a set of mathematical equations, but it is possible to present the model in a variety of ways. For example, as 3D shapes or volumes, or plotted as model geology in the 2D map view or section views of the project.

3D model operations

- In a **2D Viewer**
  - Plot the 2D model geology, being the intersection of the (3D mathematical) model with the (2D) map or section, in outline form or filled
  - Plot the model along the section markers (of intersecting sections) in the 2D viewer
  - Display or hide the plot of model geology
  - Delete the plot of model geology
- In the **3D Viewer**
  - From the 3D (mathematical) model, build 3D shapes for each geology formation
  - Display or hide the 3D representation of the model geology for any formation
  - Present a formation of the model geology as either shaded or in wireframe
  - Change the appearance of the 3D representation of a formation of the model geology

To perform 3D model operations use the **Project Explorer** or options in the **Model** menu or toolbar. See:

- Model menu, toolbar and dialog boxes (user interface reference)
- 3D Viewer (user interface reference)
- Project Explorer—Models shortcut menus (user interface reference)
- Model operations ('How to ...' instructions)

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User interface overview

Parent topic: 3D GeoModeller Reference

3D GeoModeller's user interface has the following elements. There are normally several ways of performing an operation. You may be able to perform the same operation using the main menu or a shortcut menu or a toolbar.

- 3D GeoModeller workspace. A main window, which contains the main menu and the toolbars.
  - 3D GeoModeller main menus
  - Toolbars:
    - Project menu, Project toolbar and dialog boxes
    - Section menu, toolbar and dialog boxes
    - 2D Structural sub menu and Structural toolbar
    - Points List toolbar (docked)
    - Model menu, toolbar and dialog boxes
    - 2D Viewer toolbar
    - 3D Controls sub menu and 3D Viewer toolbar
- The Project Explorer which presents in a tree structure all of the data objects managed within the project. Each node of the tree has a shortcut menu for common operations on the object it represents.
- The 2D Viewer for the display of the map and sections, and for presentation of 2D model objects. The **2D Viewer** has a shortcut menu for common operations. See 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus.
- The 3D Viewer for the display and presentation of 3D model objects. The **3D Viewer** has a shortcut menu for common operations. See 3D Viewer sub and shortcut menu.
- The Points List enables you to enter data or specify parameters by clicking points in the 2D Viewer.

3D GeoModeller workspace

Parent topic: User interface overview

In this section:

- 3D GeoModeller workspace—Introduction
- Status bar and conventions for spatial coordinates

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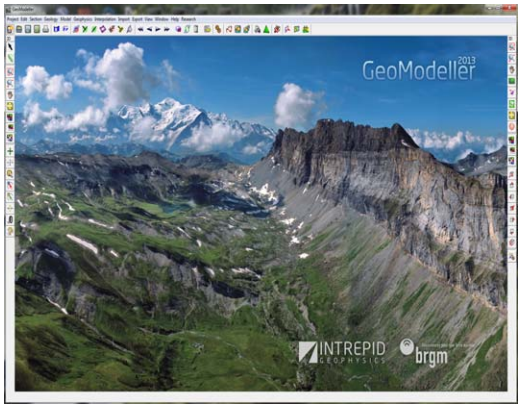
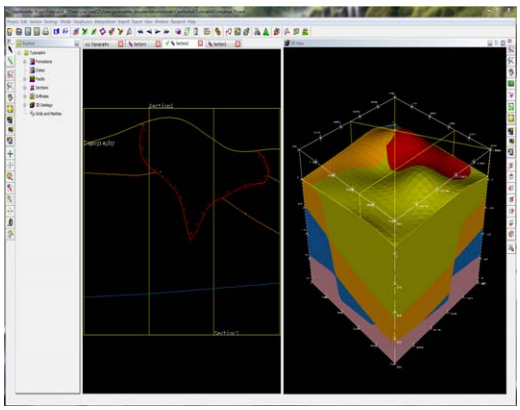
3D GeoModeller workspace—Introduction

Parent topic: 3D GeoModeller workspace

When you launch 3D GeoModeller, main window appears with the main menu and toolbars.



When a project opens, the interface expands to present a workspace, the upper part of which has the main menu and toolbars, and a lower part containing a number of dockable windows.



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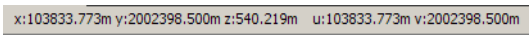
Status bar and conventions for spatial coordinates

Parent topic: 3D GeoModeller workspace

In the **Status Bar**, the **Points List Editor** and the **Tape Measure**, 3D GeoModeller uses the following notation to describe spatial coordinates.

As you point to a position in the 2D Viewer, 3D GeoModeller displays the coordinates of the point in the **Status Bar**.



See also:

- Points List Editor (floated)
- Tape Measure

Y indicates that the term is present in the 3D GeoModeller feature.

Notation	Purpose	Status bar	Points list	Tape measure
n or #	Number of point in sequence		Y	Y
x, y, z	x, y, z coordinates of point	Y	Y	Y
u, v	Local coordinates in the current plane	Y	Y	Y
xyz, uv, Length, Distance	Distance to previous point In **Tape Measure**, if you are measuring the **Topography** section, you need to take care when measuring steep terrain: • **xyz** takes vertical distance into account • **uv** takes only horizontal (xy) distance into account		Y	Y
Bearing	(**Tape measure**) Angle with respect to the v direction in degrees, clockwise positive			Y
Angle	(**Points list editor**) Angle with respect to the v direction in degrees, clockwise positive (**Tape measure**) Absolute angle with respect to the previous line segment in the list, where 180° is the direction of a continuation of the line of the two previous points and 0° is the direction of the line from the previous point to the one before, in degrees, in the range 0..180		Y	Y

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Project Explorer

Parent topic: **User interface overview**

In this section:

- Project Explorer—Introduction
- Common shortcut menu options
- Project Explorer—Project Explorer window and Project shortcut menus
- Project Explorer—Formations shortcut menus
- Project Explorer and 2D Viewer—Faults shortcut menus
- Project Explorer—Models shortcut menus
- Project Explorer—Sections shortcut menus
- Project Explorer and 2D Viewer—Drillholes shortcut menus
- Project Explorer and 2D Viewer—Drillhole Visualisation
- Project Explorer and 2D Viewer—Drillhole Edit
- Project Explorer—Surface meshes shortcut menu

Project Explorer—Introduction

Parent topic: **Project Explorer**

The **Project Explorer** is a special master window, which presents all of the data objects of a project in an tree structure. It provides you with an overview of the entire project data.

It has a tree structure containing all of the data objects of the project. It provides a global view of the entire project with all of its components. You can use it to perform certain actions without needing to use the **2D Viewer** to select an object.

Shortcut menus are available for every node of the **Project Explorer** tree, offering appropriate options for the associated object, object type or object group. Shortcut menus are generally the same for any context **Project Explorer** and in the **2D Viewer** and **3D Viewer**.

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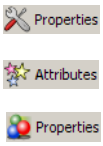
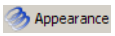
Common shortcut menu options

Parent topic: Project Explorer

In the **Project Explorer** you can select shortcut menu options for all objects or types of objects in the project. Some menu options are common to several object types and enable similar operations. The following table contains an overview of the common shortcut menu options

Option	Description	Icon
Properties, **Attributes**	Display the properties dialog box for the object. Selecting Properties for Drillholes opens the drillhole log visual.	
Show, **Hide**	Display or hide the object or group of objects in the viewers	
Wireframe	Display: • Wireframe for a 3D model volume or a group of volumes • Outlines for other data	
Shading	Display: • Formation shading in a 3D model volume or group of volumes • Background colour for a section or group of sections.	
Appearance	Display the **Appearance of an object** dialog box for the object or the group of objects. **Appearance** for **Drillholes** allows the drillhole display diameter to be changed If you set appearance for a group of objects, 3D GeoModeller applies the settings to future new objects in the group. See Appearance of objects dialog box family.	
Delete	Delete the object or group of objects	

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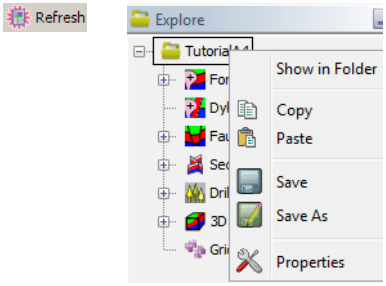
Project Explorer—Project Explorer window and Project shortcut menus

Parent topic: Project Explorer

Use **Project Explorer** window shortcut menu option **Refresh** to refresh the **Project Explorer**

Use the Project object shortcut menu to save the project, show the project in its folder, or display properties.



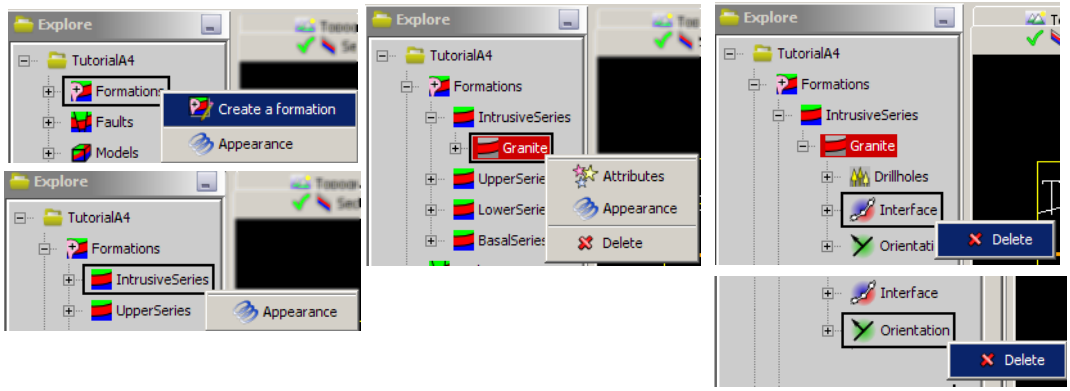
Options in these menus.

Option	Description
Save, **Save As**	See Save a project (and Save As ...).
Properties	See Project Properties dialog box.

Project Explorer—Formations shortcut menus

Parent topic: Project Explorer

The **Project Explorer** shortcut menus for **Formations** generally, individual series and individual formations enable you to work on those objects at different levels of grouping.



Options in these menus.

Option	Description
Create a formation	See Create or Edit Geology Formations dialog box
Appearance	Edit the appearance of the object or group of objects. See Appearance of objects dialog box family.
Attributes	See Edit Geological Formation Attributes dialog box
Delete	Delete the object or group of objects or data

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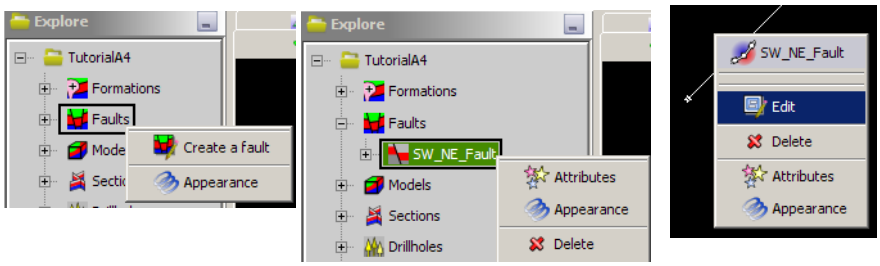
Project Explorer and 2D Viewer—Faults shortcut menus

Parent topic: Project Explorer

The **Project Explorer** shortcut menus for **Faults** generally and for individual faults enable you to work on those objects together or individually.

The **Fault** shortcut menu in the **2D Viewer** enables you to work on individual faults.

These menus are similar, so we describe them in the same section.



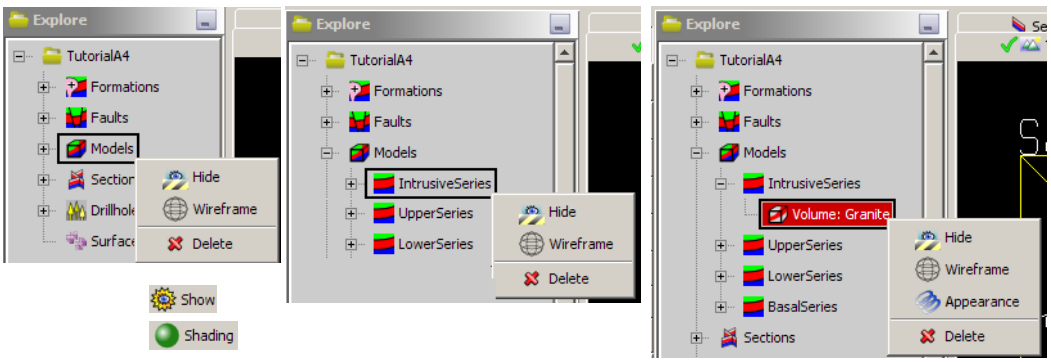
Options in these menus.

Option	Description
Create a fault	See Create or Edit Faults dialog box.
Appearance	Edit the appearance of the object or type of object. See Appearance of objects dialog box family
Attributes	See Fault Properties (attributes) dialog box.
Edit	See Create or Edit Faults dialog box
Delete	Delete the fault

Project Explorer—Models shortcut menus

Parent topic: Project Explorer

The **Project Explorer** shortcut menus for the current **3D Model** and its components enable you to work on those objects in groups or separately.



Options in these menus.

Option	Description
Show, **Hide**, **Shading**, **Wireframe**, **Appearance**	See Common shortcut menu options.

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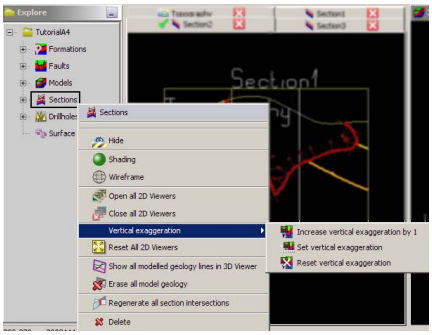
Project Explorer—Sections shortcut menus

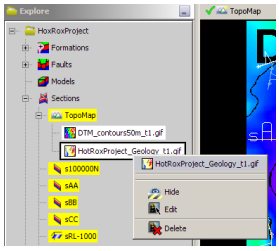
Parent topic: Project Explorer

The **Project Explorer** shortcut menus for **Sections** generally, individual sections or topography and images attached to a section enable you to work on those objects at different levels of grouping or individually.

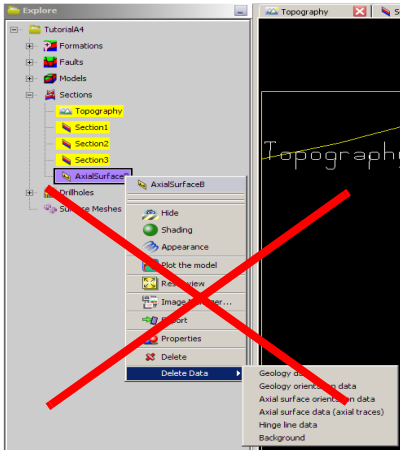
This section describes the **Sections** shortcut menu (for all sections together) and the shortcut menu for images attached to sections. For information about the shortcut menu of topography, individual sections and axial surfaces, see 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus



Sections shortcut menu



Section > image shortcut menu



Section shortcut menu (described elsewhere—see 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus)

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Options in these menus

Option	Description
Show, **Hide**, **Shading**, **Wireframe**, **Appearance**	See Common shortcut menu options. For images: • Rotate through the images attached to the section using the PAGEUP and PAGEDOWN keys. • Hide the image using the END key.
Open, **Close all 2D Viewers**	(**Open**) Open a **2D Viewer** window for all sections. (**Close**) Close all **2D Viewers**
Vertical Exaggeration	See Vertical exaggeration submenu and toolbar.
Reset all viewers	Adjust pan and zoom of each 2D Viewer window so that the display is all visible and fills the window.
Show (or hide) all modelled geology lines (or polygons) in 3D Viewer	(**Show**) For each section where model data is visible (**lines** or **polygons** or both), display the same data in the 3D Viewer. (**Hide**) Hide all model data displayed on sections in the 3D Viewer
Erase all model geology	Erase model display from all sections in the 2D Viewer and 3D Viewer
Regenerate all section intersections	Choose this option to force 3D GeoModeller to regenerate section intersections. If you change the model precision or topography, you need to update the relationships between sections.
Edit	(Images only) See Edit and Align Image dialog box
Delete	(Sections) Delete all sections from the project (Images) Delete the image from the project

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Project Explorer and 2D Viewer—Drillholes shortcut menus

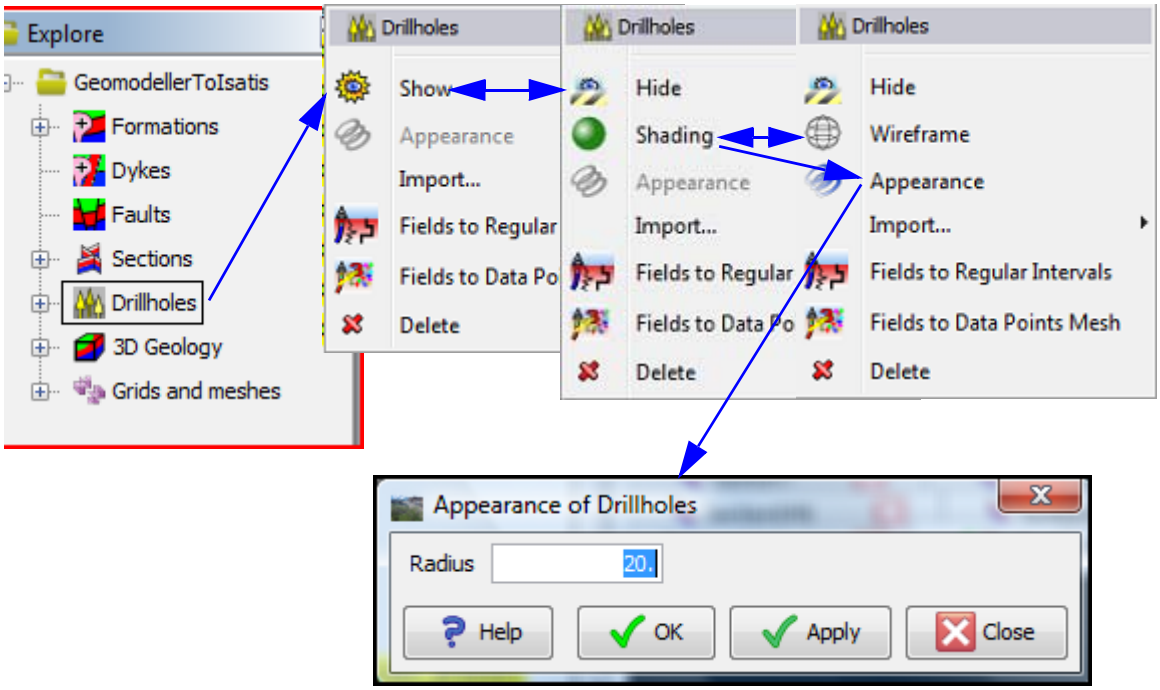
Parent topic: Project Explorer

The **Project Explorer** context menus for **Drillholes** enable you to work on those objects together or individually.

The **Drillhole** context menu in the **2D Viewer** enables you to work on individual drillholes.

These menus are similar, so we describe them in the same section.

- The following functions are available from the main **Explore** > **Drillholes** context menu



Functions in the Drillholes context menu.

Function	Description
Show, **Hide**	See Common shortcut menu options.
Shading, Wireframe	See Common shortcut menu options
Appearance	Accessible in Shading Mode only; change the Drillhole radius in the 3D Viewer. See Appearance of Drillholes dialog box
Import	See Importing drillholes and drillhole geophysical logs and assays
Fields to Regular Intervals	Recalculate Fields to a regular From/To interval
Fields to Data Points Mesh	From Explore Context Menu: Drillhole fields to data points mesh
Delete	Delete all drillholes from the project

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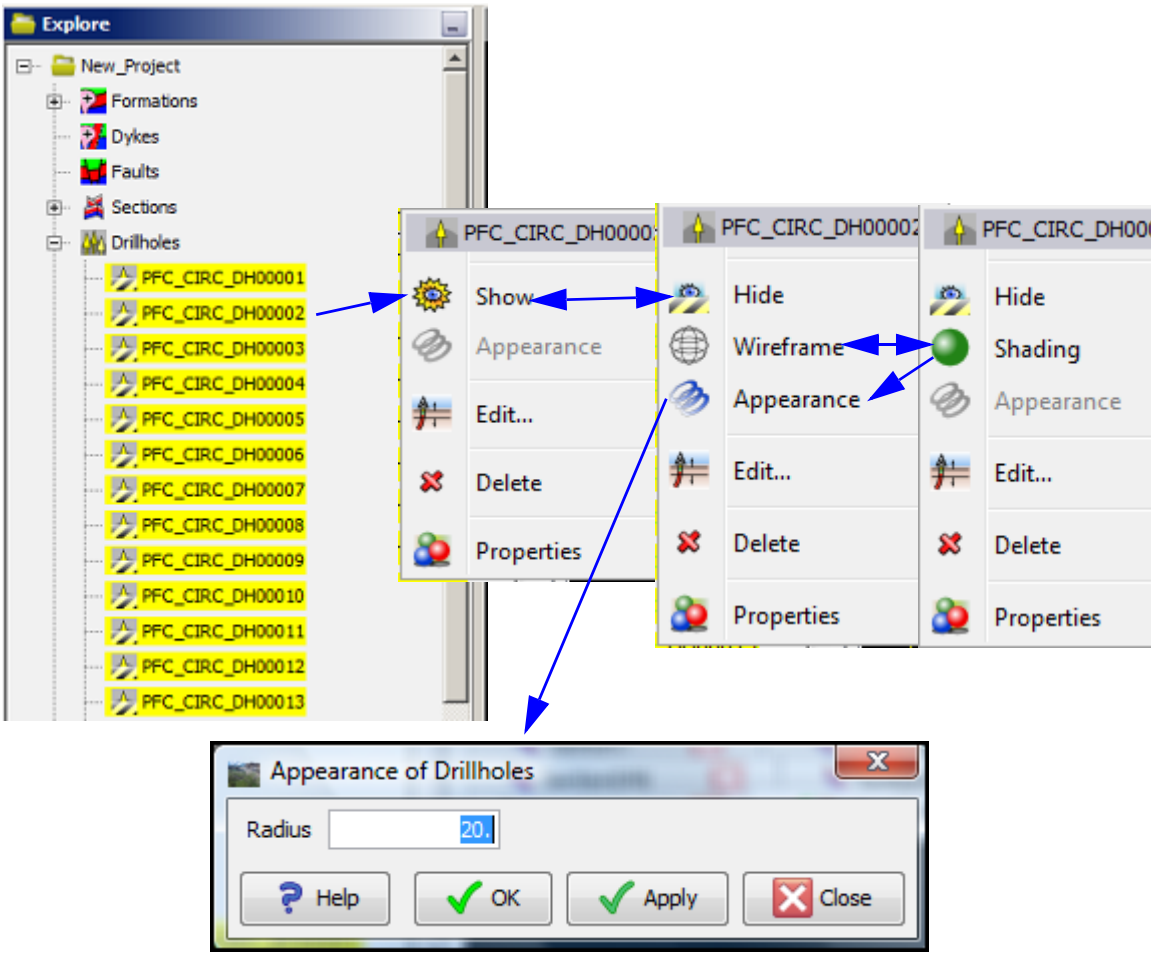
- The following functions are available from the main **Explore** > **Drillholes** > **DrillholeName** context menu ie RightClick on an individual drillhole in the list



Options in the individual Drillhole context menu.

Option	Description
Show, **Hide**	See Common shortcut menu options.
Shading, Wireframe	See Common shortcut menu options
Appearance	Accessible in Shading Mode only; change the Drillhole radius in the 3D Viewer. See Appearance of Drillholes dialog box
Edit	Edit an individual drillhole
Delete	Delete all drillholes from the project
Properties	Display the selected drillhole in the Drillhole Viewer

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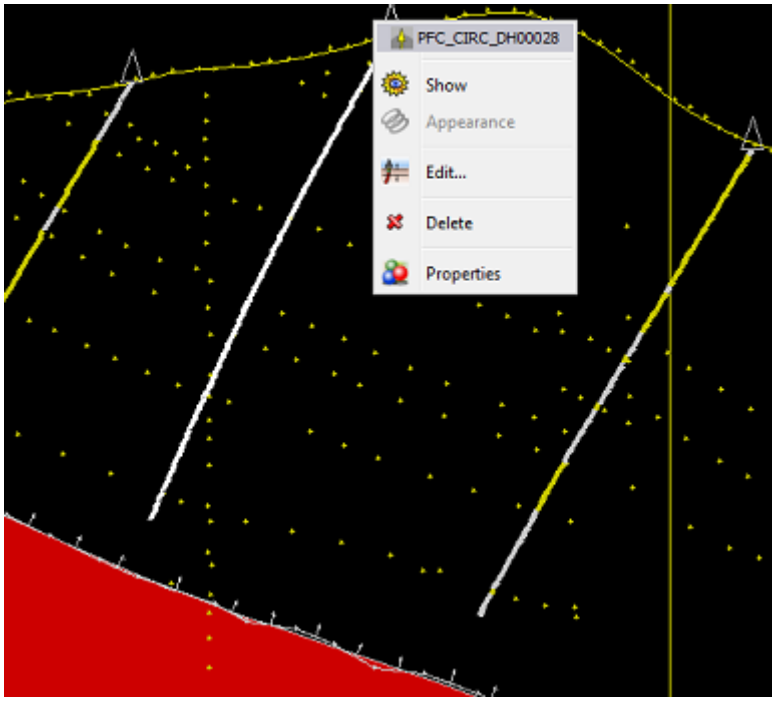
- The following functions are available from the context menu of a selected Drillhole in the **2D Viewer** ie RightClick on a selected drillhole.



Options in these menus.

Option	Description
Show, **Hide**	Show/Hide the selected drillhole in the **3D Viewer** See Common shortcut menu options
Appearance	Inactive in the 2D Viewer
Edit	Edit an individual drillhole
Properties	Display the selected drillhole in the Drillhole Viewer
Delete	Delete the selected drillhole from the project

The Drillhole **Fields to Regular Intervals**, Drillhole **Properties** and Drillhole **Editing** functions are discussed in detail below.

Project Explorer and 2D Viewer—Drillhole Visualisation

Parent topic: Project Explorer

Drillhole Properties

- **Display the selected drillhole in the Drillhole Viewer**

Selecting Properties from any of the Explore Drillhole context menus opens the drillhole log in a graphic viewer. The viewer displays the drillhole as a section down the hole path with the following features:

- Depth labels at regular depth intervals down the hole path.
- Logged Geology in the current Model Pile colours.
- Computed Model Geology in the current Model Pile colours.

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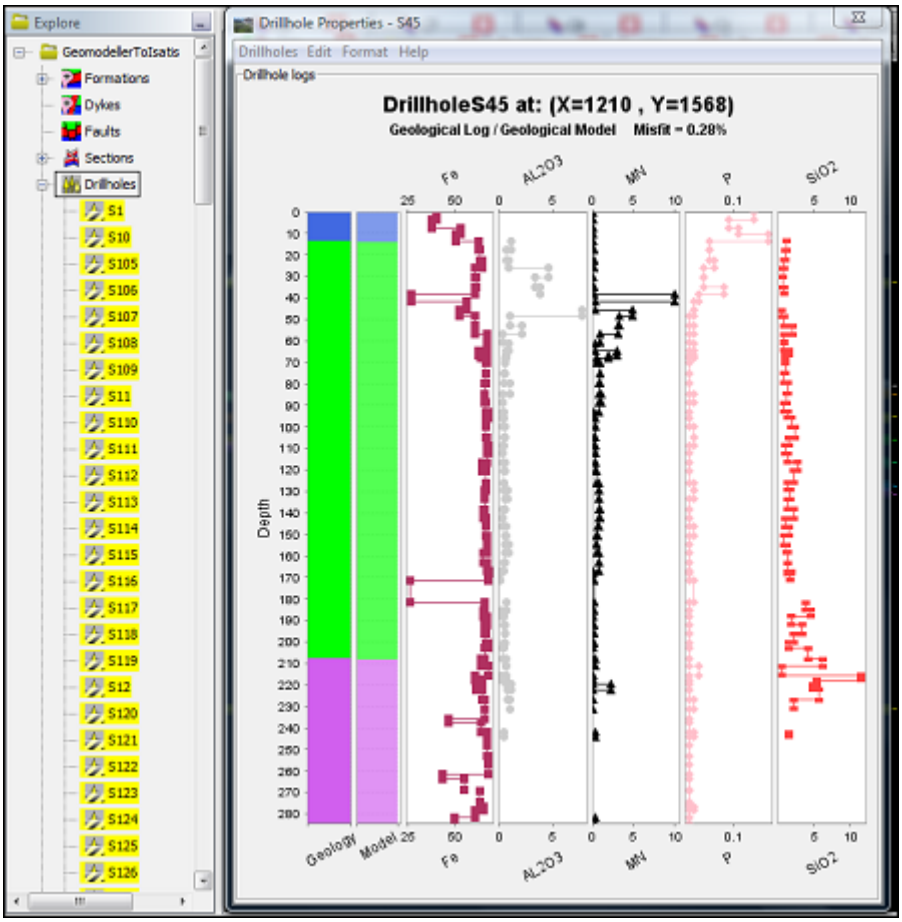
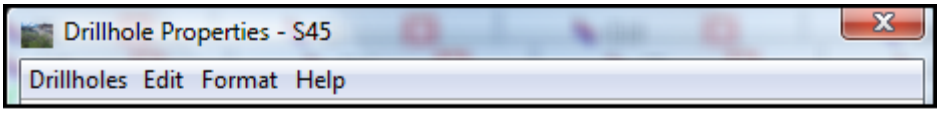
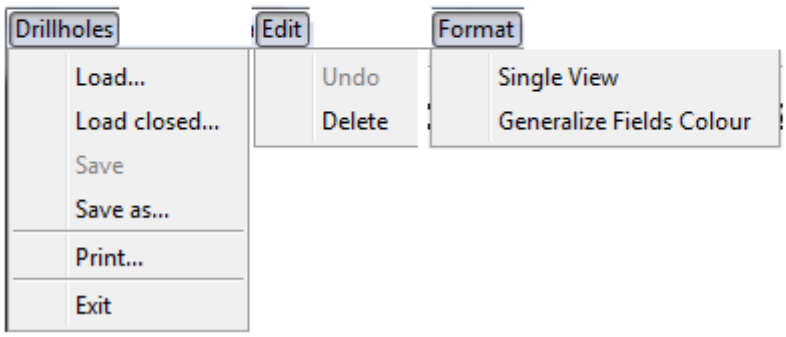
- From/To profiles of numeric Fields (autoscaled) on the same depth axis as the Geology
- Log title with Holename, X,Y Collar coordinate and a Misfit estimate of the Logged versus Modelled geology.



The **Drillhole Properties Viewer** has a set of dropdown menus which provide the following functionality. The **Help** menu is inactive.





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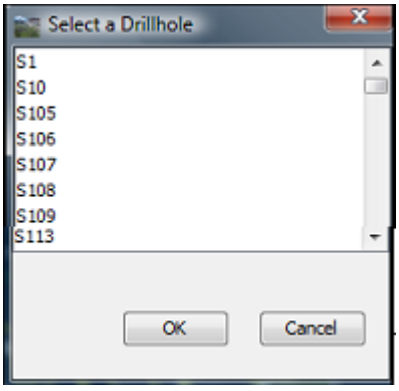
Options in the Drillhole Properties menus.

Option	Description
Drillholes > Load	Open a Drillhole log for the selected drillhole - Drillholes > Load > Select a Drillhole
Drillholes > Load closed...	Select Drillhole within specified distance of the current drillhole - Drillholes > Load Closed... > Select a Drillhole within Range
Drillholes > Save	Inactive in this Mode. See Drillhole Edit. Save an interactive Edit operation.
Drillholes > Save as	Save the current Drillhole log to a PNG file
Drillholes > Print	Print the current drillhole log view to the selected Printer
Drillholes > Exit	Exit from the current drillhole properties viewer
Edit > Undo	Inactive in this Mode. See Drillhole Edit. Undo an interactive Edit.
Edit > Delete	Delete the current drillhole from this Project
Format > Fields: Single View	Display all numeric Field profiles overlayed in one panel
Format > Fields: Multiple Views	Display all numeric Field profiles in individual panels (Default)
Format > Generalize Fields Colour	Not active in this release.
Help >	Help Menu inactive in this release.

- **Drillholes > Load > Select a Drillhole**
  - Select and Click OK to open another Drillhole log



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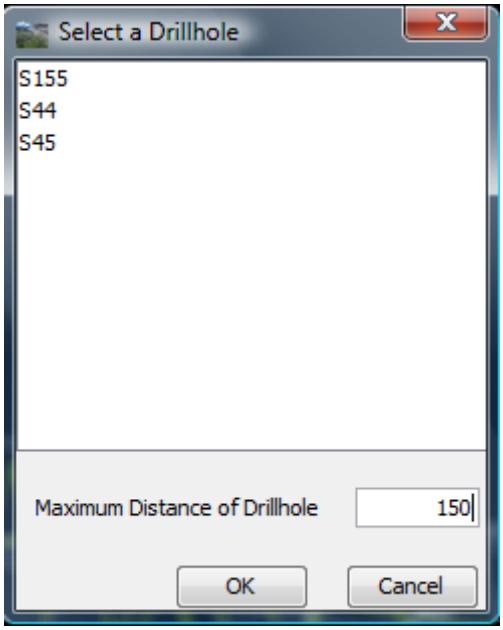
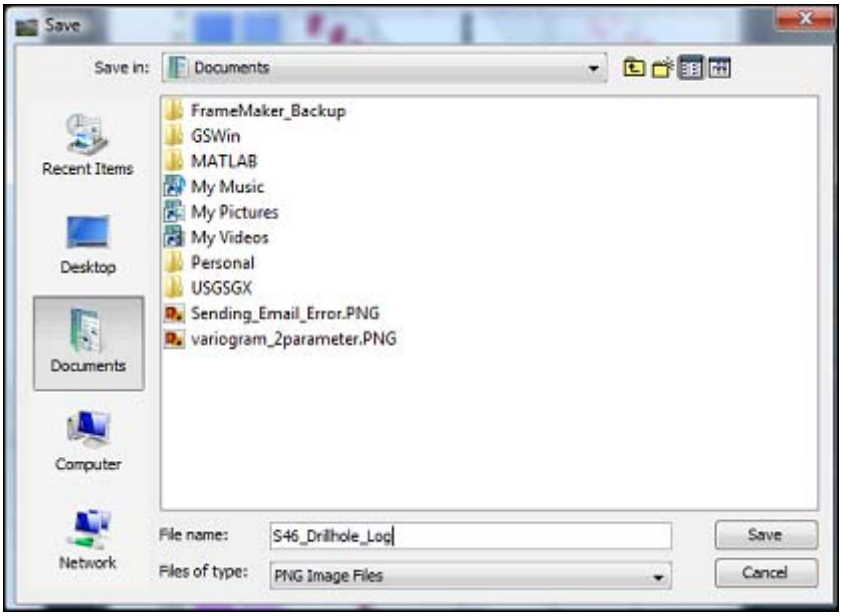
- **Drillholes > Load Closed... > Select a Drillhole within Range**



  - Choose a maximum distance within which to find a neighbouring hole.
  - Select a drillhole from the list and click OK to view the Drillhole log
- **Drillholes > Save As**
  - **Save the current Drillhole log to a PNG file**
  - The standard file Save dialog opens; select a path and enter a name for the PNG file.



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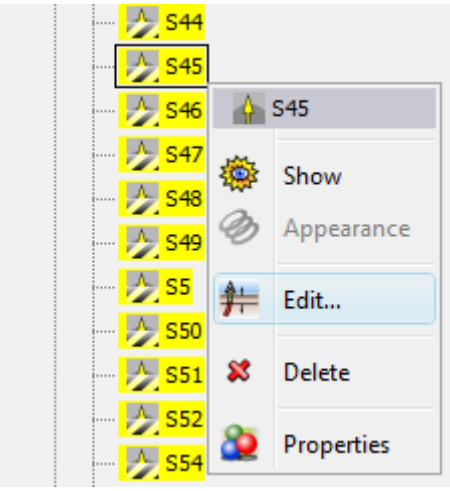
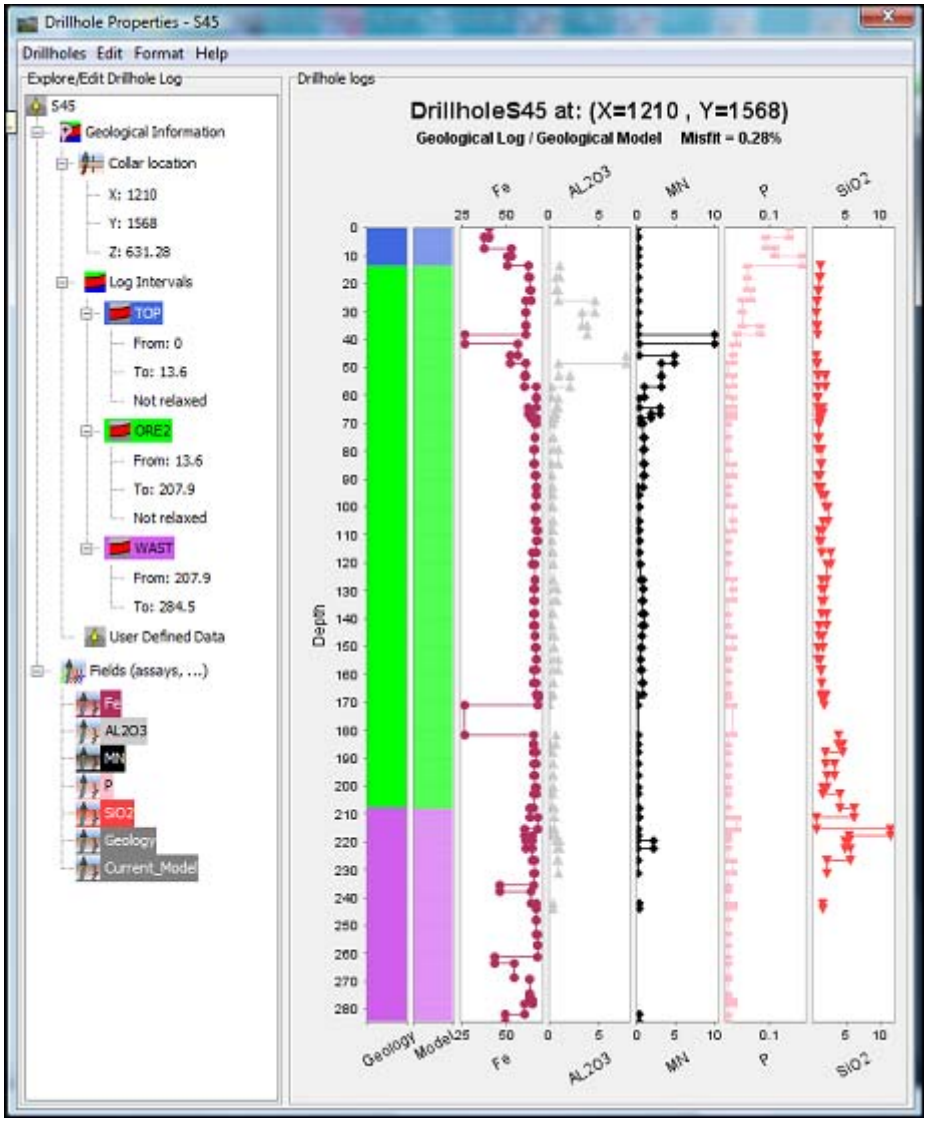
Project Explorer and 2D Viewer—Drillhole Edit

Parent topic: Project Explorer

- **Edit an individual drillhole**
  - Left mouse select an individual drillhole from the tree and choose Edit



  - The **Drillhole Properties** dialog opens with the Editing options activated and with the additional interactive **Explore/Edit Drillhole Log** pane on the left



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- The Top level Menus **Drillholes** and **Edit** described as inactive under **Drillhole Properties** now support the following extra options.

Drillholes > Save	Save Editing operations completed on the current drillhole
Edit > Undo	Undo Editing operations completed on the current drillhole

- **Explore Edit Drillhole log** (Left Side Panel tree) - Drillhole interactive editing in the left side panel of the **Drillhole Properties** dialog supports the following operations
  - Edit a Drillhole Collar location by clicking on **Collar location** and editing the coords in the popup dialog or by clicking on X or Y or Z individually.
  - Edit a Lithology From/To.
  - Edit the Lithology of a From/To using the drop down Formation list.
  - Define a Lithology interval as Relaxed or Not Relaxed (Default).
  - Delete a Numeric field ie Fe assay etc.
  - Edit the Appearance of a Numeric field (Profile colour, Vertex Symbol).
  - Hide/Display a Numeric profile.
  - Calculate and Display the histogram of a Drillhole numeric field.
  - Save/Undo any Edits or Visual changes to a Drillhole.
  - The **Fields (assays),...** right click context menu has the following options
    - Multi Cross Plot Analysis (Also available under Meshes and Grids once the drill numeric fields are converted to a Vertex Mesh)
    - Show All Numeric Fields
    - Generalise these Graphic Aspects
    - Delete All Numeric Fields
    - Create Fields on Constant Support (Also available from the context menu accessible from the Drillholes item in the main Explore tree)

None of these options are saved until the user selects the **Drillholes>Save** option in the Top level menu as described above. Any of these operations can be undone by selecting **Undo** in the top level **Edit** menu.

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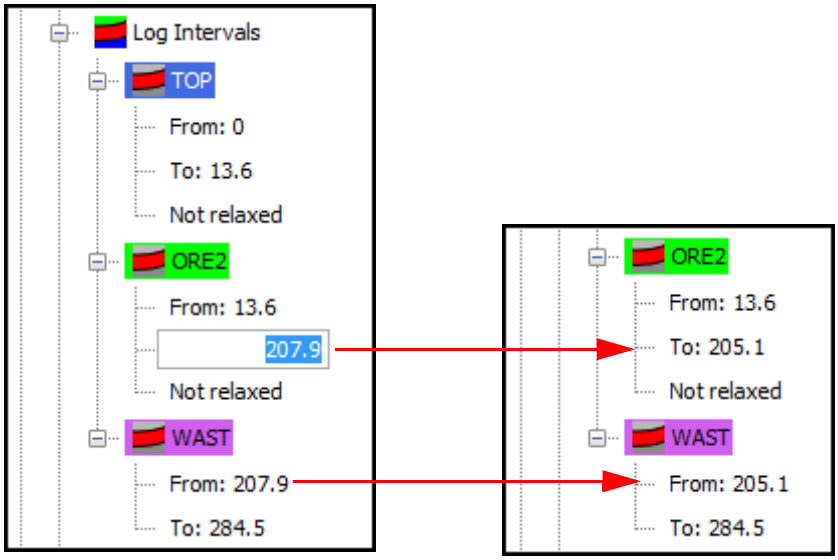
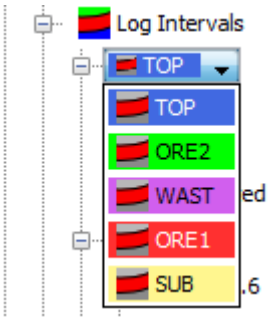
- **Edit a Lithology From/To**



  - Edit the **To:** depth for ORE2 from 207.9 to 205.1 and press the ENTER key to update the ORE2 **To:** depth to 205.1.
  - This change will force an update of the WAST **From:** depth to 205.1 to match the updated **To:**. No gap will be created.

- **Editing the Lithology of an existing From/To Interval**



  - Left Click on the Interval Formation Icon and select a Formation from the dropdown list

- **Define a Lithology interval as Relaxed or Not Relaxed (Default)**
  - Click on the **Not relaxed** item at the foot of a Lithology interval and it will change to **Relaxed** as shown in the example for TOP below. This option is not available for the last interval in a drillhole since the end point is not a real contact ie the hole stops within this unit. This depth point is always relaxed but is available for use with the Compute **Inequality** option discussed in the Note below.
  - If a lithology interval is relaxed, the contact point at this interface will not be used to compute the model.
  - When the Lithology interval is relaxed a new column appears beside the modelled geology column in the right hand panel. This is the **User Defined Data** column and the horizontal black bar indicates that the contact between TOP and ORE2 is relaxed as shown in the example figure below.
  - A **Relaxed Interface** is also added to the **User Defined Data** section of the **Explore/Edit Drillhole Log** panel (see below).

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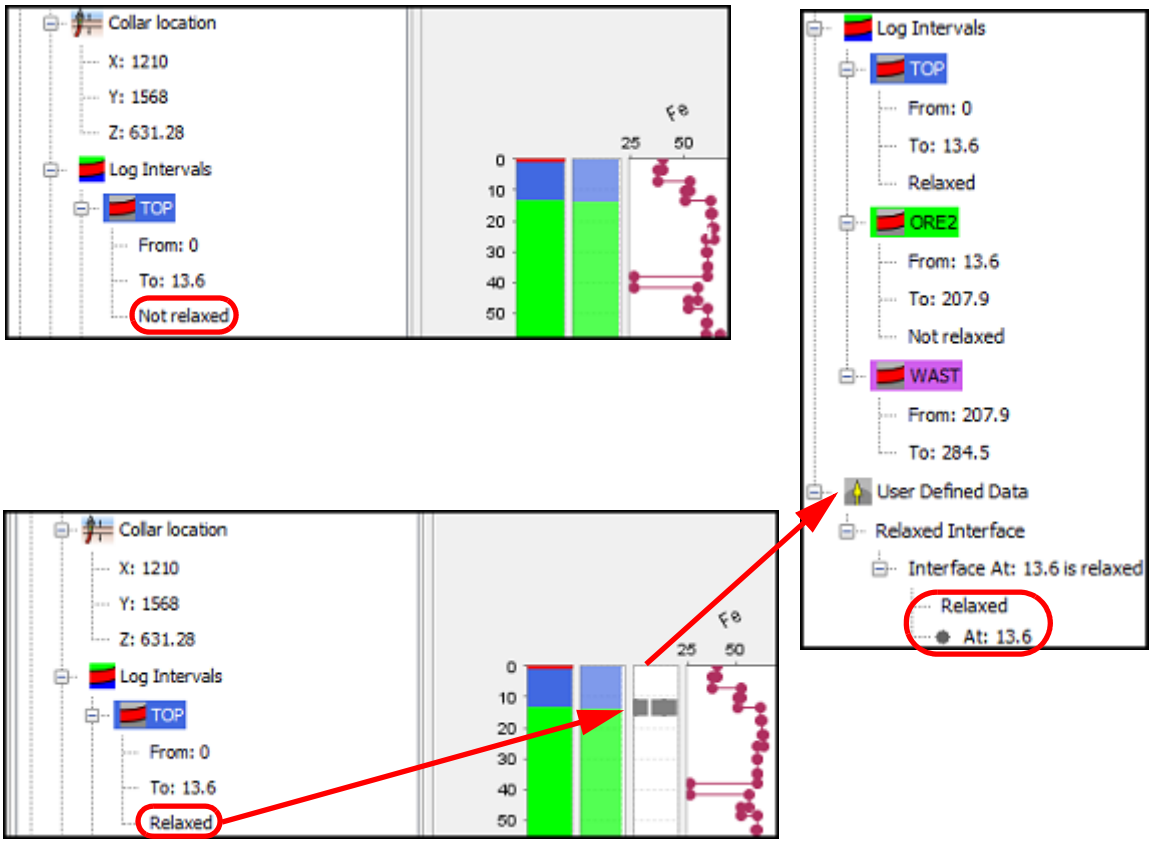
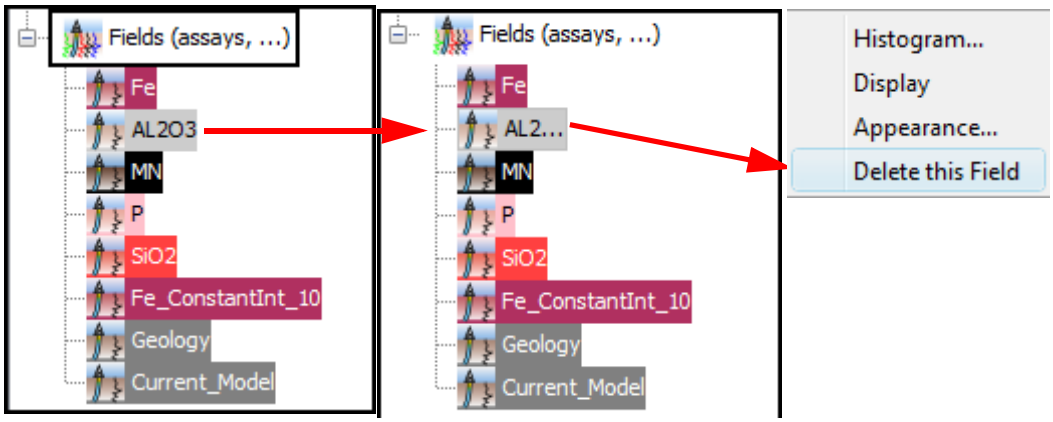
Note: Drillhole lithology contact points are added to the geological model data as 3D contact points if the drillhole is selected in the **Model->Compute** dialog. Any orientation data added to the drillhole is also used in the Compute. The last lithology interval **To:** point at the drillhole bottom is also added as a lithology constraint point but is only active if the **Inequality** toggle is selected in the **Model->Compute** panel.



- **Delete a Numeric field ie Fe assay etc**
  - Right click on a numeric field in the list at the base of the **Explore/ Edit Drillhole Log** panel and select **Delete this Field**



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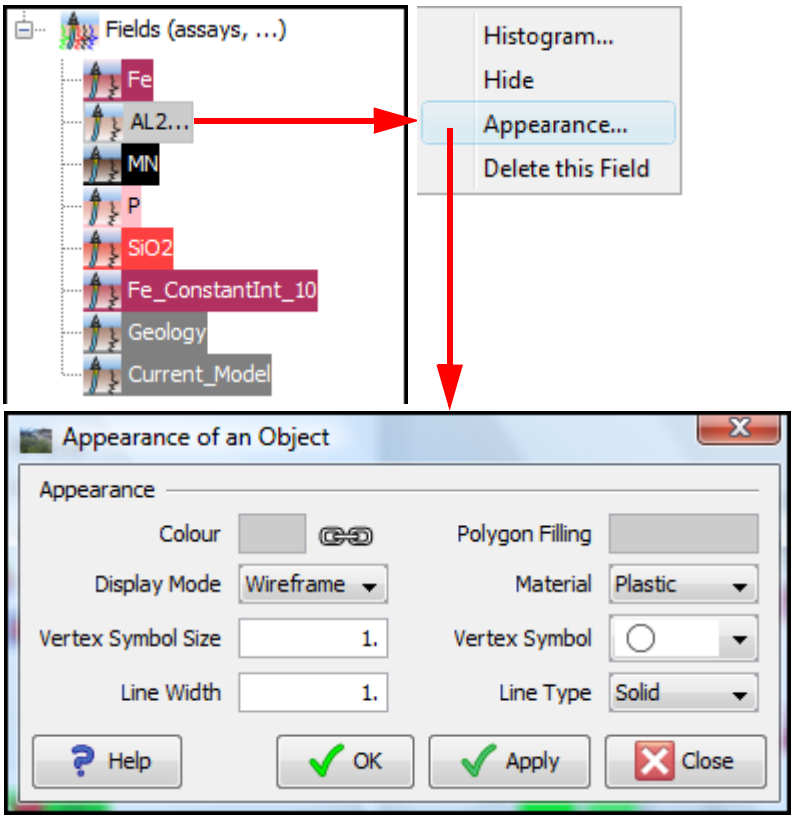
- **Appearance - Edit the Appearance of a Numeric field (Profile colour, Vertex Symbol)**
  - The Appearance of the numeric **Fields (assays,...)** column display can be edited by Right Clicking on the Field and selecting **Appearance** then choosing from the display options in the **Appearance of an Object** dialog



  - Editable options are:

    Colour - Profile colour.

    Vertex Symbol - Drawn at the From/To points.

  - The following options are NOT active:

    Polygon Filling

    Display Mode

    Material

    Vertex Symbol Size

    Line Width

    Line Type

  - Changes are not visible until saved and the Drillhole Viewer is reopened.
  - Appearance changes saved are applied to the chosen field in all Drillholes.
  - The Vertex Symbol shown in the **Appearance of an Object** dialog does not reflect the symbol currently in use for the Field profile column.
  - When the Appearance Editor is reopened for a chosen field then the Vertex Symbol reverts to its default type in the Field column display.

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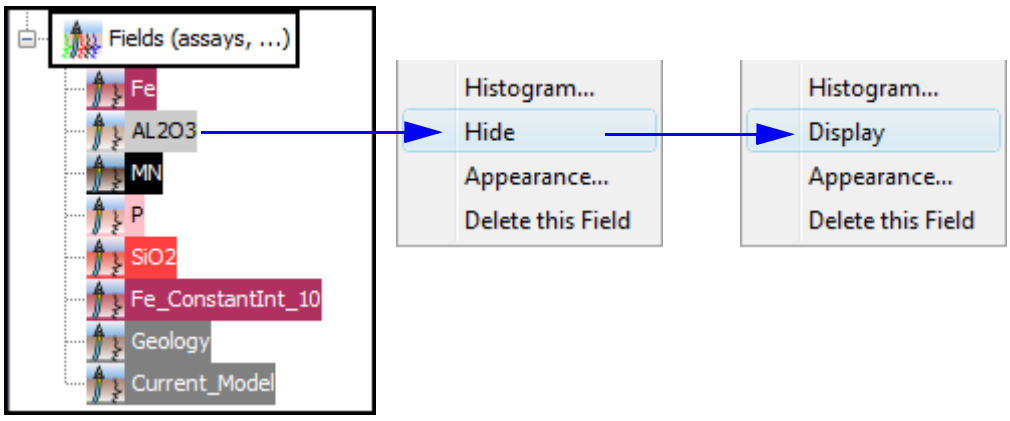
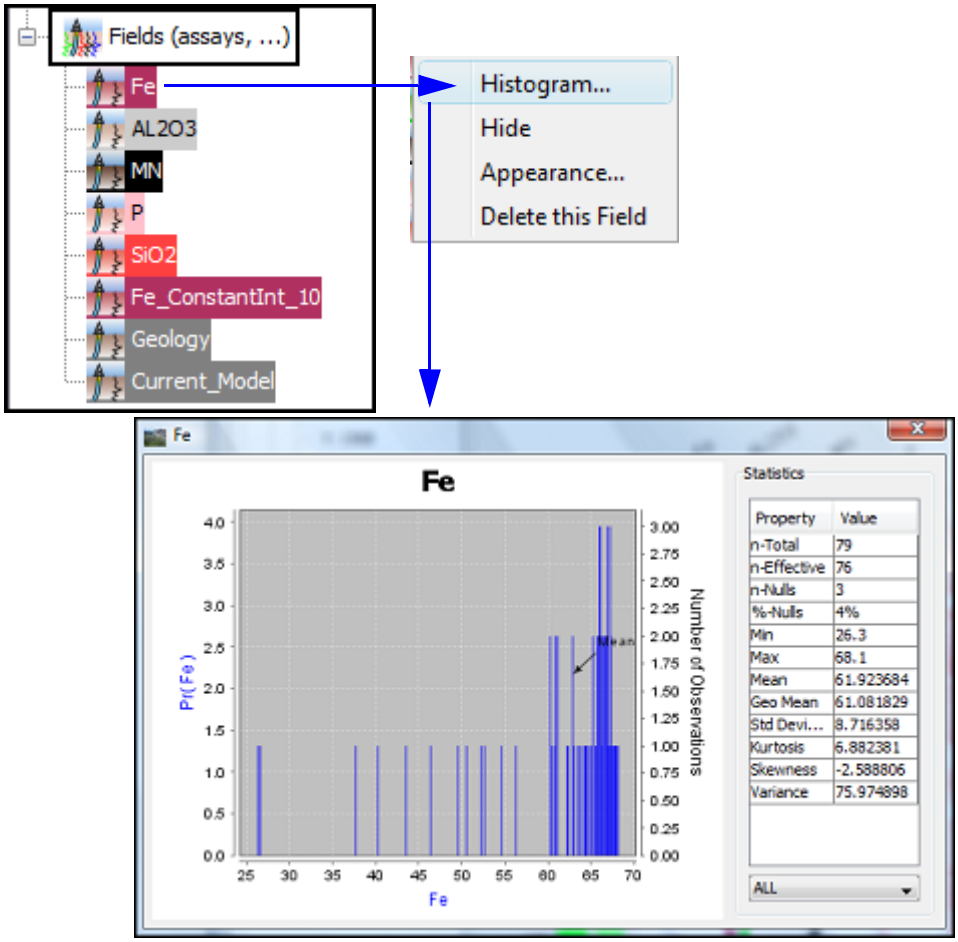
- **Hide/Display a Numeric profile**
  - Right Click on Assay field and select **Hide/Display**



- **Histogram - Calculate and Display the histogram of a Drillhole numeric field**
  - Right Click on Field and select Histogram, The histogram and summary statistics for the selected field in the current drillhole are displayed.



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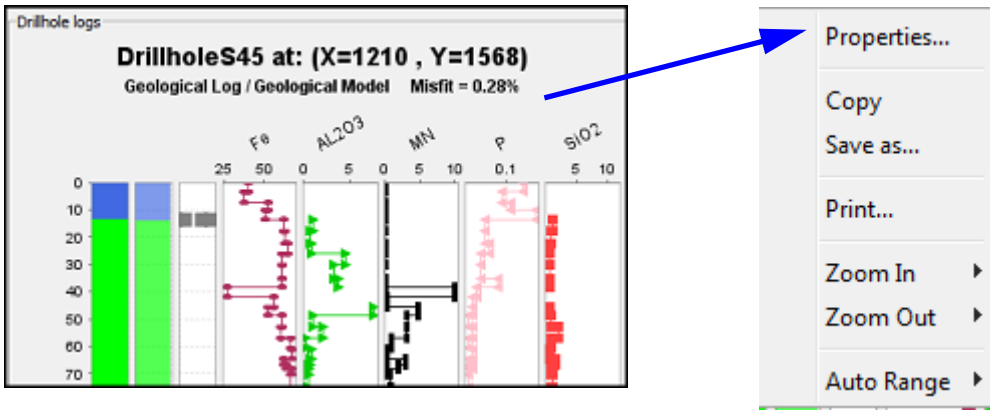
- **Drillhole logs** (Right Side Panel columns) - Drillhole interactive editing in the right side panels of Drillhole Properties of the **Drillhole Properties** dialog by left/right mouse clicks and context menu selection supports the following operations
  - Right Click Menu options:
    - **Properties**: Edit the Properties of the Drillhole logs column display; the most siginificant of these is to change the vertical drillhole column layout to horizontal and to manipulate the axes scales and zoom.
    - **Copy**: Copy the Drillhole log view to the Clipboard
    - **Save as..**: Save the Drillhole log to a PNG
    - **Print**: Print the Drillhole log to a Windows printer
    - **Zoom In**
    - **Zoom Out**
    - **Auto Range**
  - Menu options available when double click in the Geology, Model, User Defined or Assay Field columns.
    - Choose a Formation for the current interval from the drop down list (top menu item).
    - **Remove Interval**: Remove a Lithology interval from the drillhole log
    - **Split Interval**: Split an existing Lithology interval; also used to Add an interval.
    - **Add Orientation Data** to the drillhole log
    - **Relax/Unrelax this Interface**: Relax or unrelax the current interface

None of these options are saved until the user selects the **Drillholes>Save** option in the Top level menu as described above. Any of these operations can be undone by selecting **Undo** in the top level **Edit** menu.

- **Properties** - Right Click in **Drillhole logs** panel and select **Properties**



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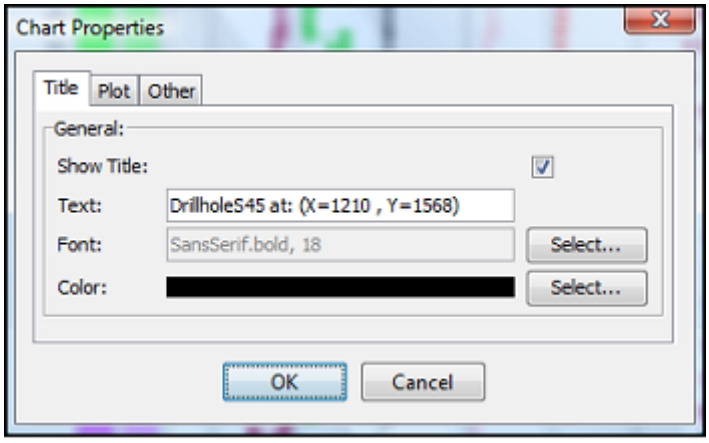
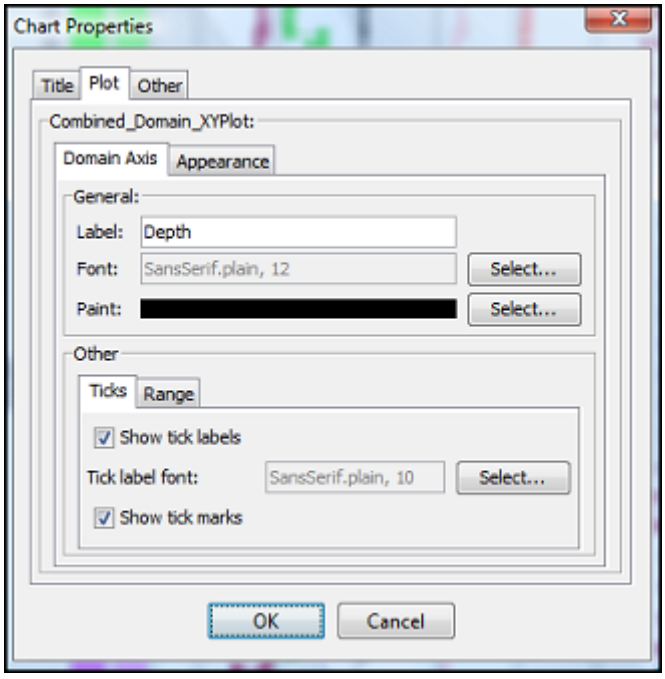
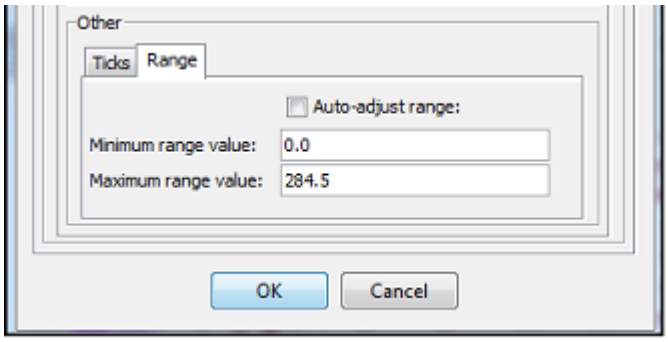
- The Tabs available in the **Chart Properties** dialog are listed below.
  - Title - Set Text, Font and Colour



  - **Plot->Domain Axis** (Depth Axis) - Set Label, Font and Axis Colour
  - **Plot->Domain Axis>Ticks** - Set Axis Labels and Tick Marks.



  - **Plot->Domain Axis>Range** - Set Min/Max Depth Range - Defaults to the full drillhole length



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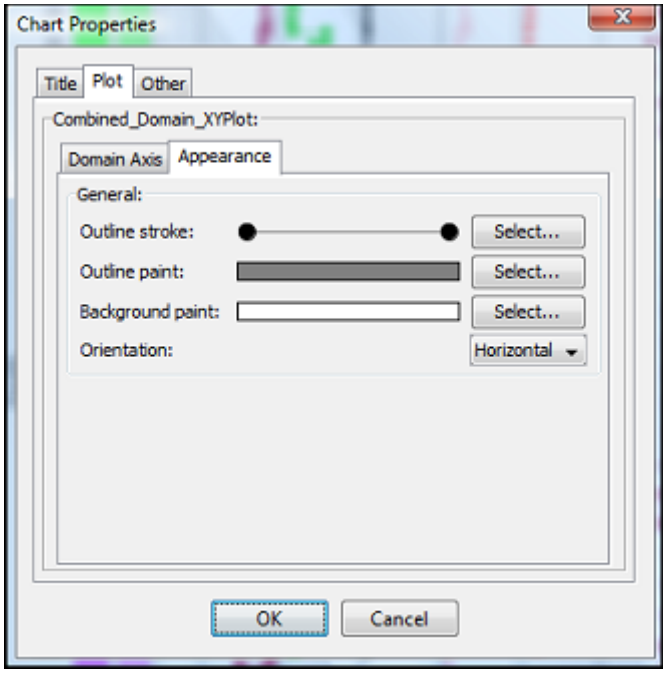
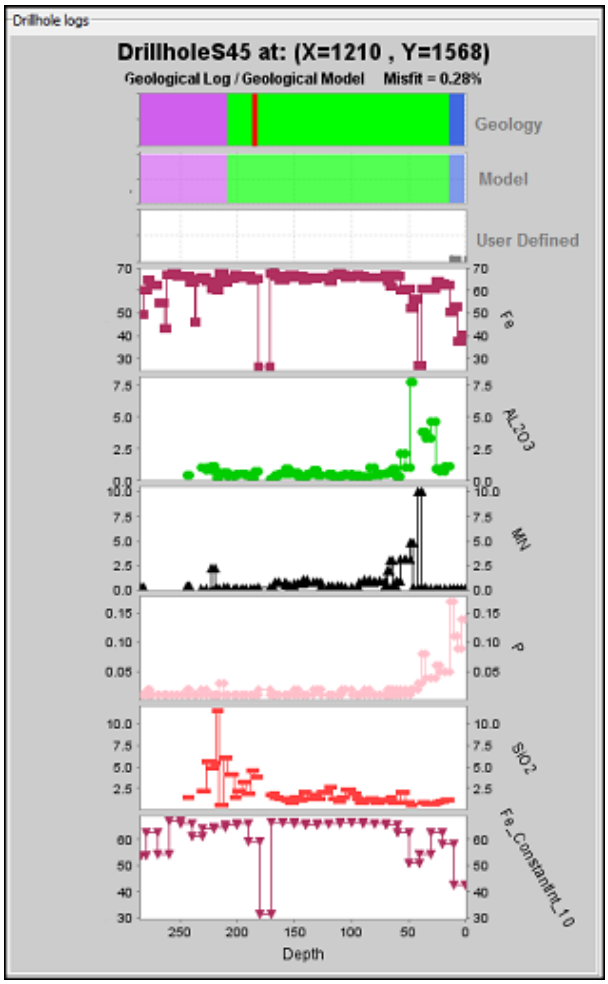
- **Plot->Appearance** - Set Outline Stroke, Outline paint (Colour), Background paint (Colour) and Orientation
- **Orientation** is the most interesting changing the drillhole log layout from Vertical to Horizontal





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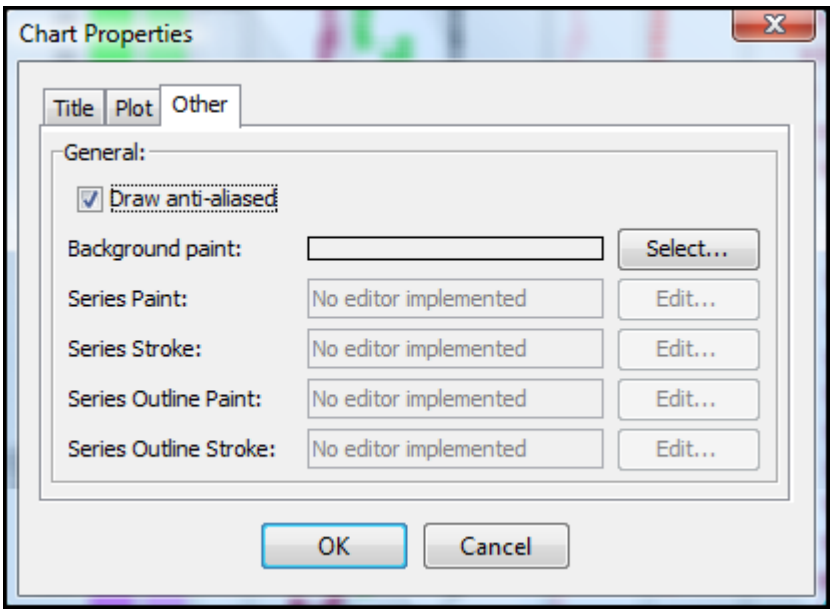
- **Other** - Set the Drillhole log **Background paint** (colour); see dark grey background in the example above



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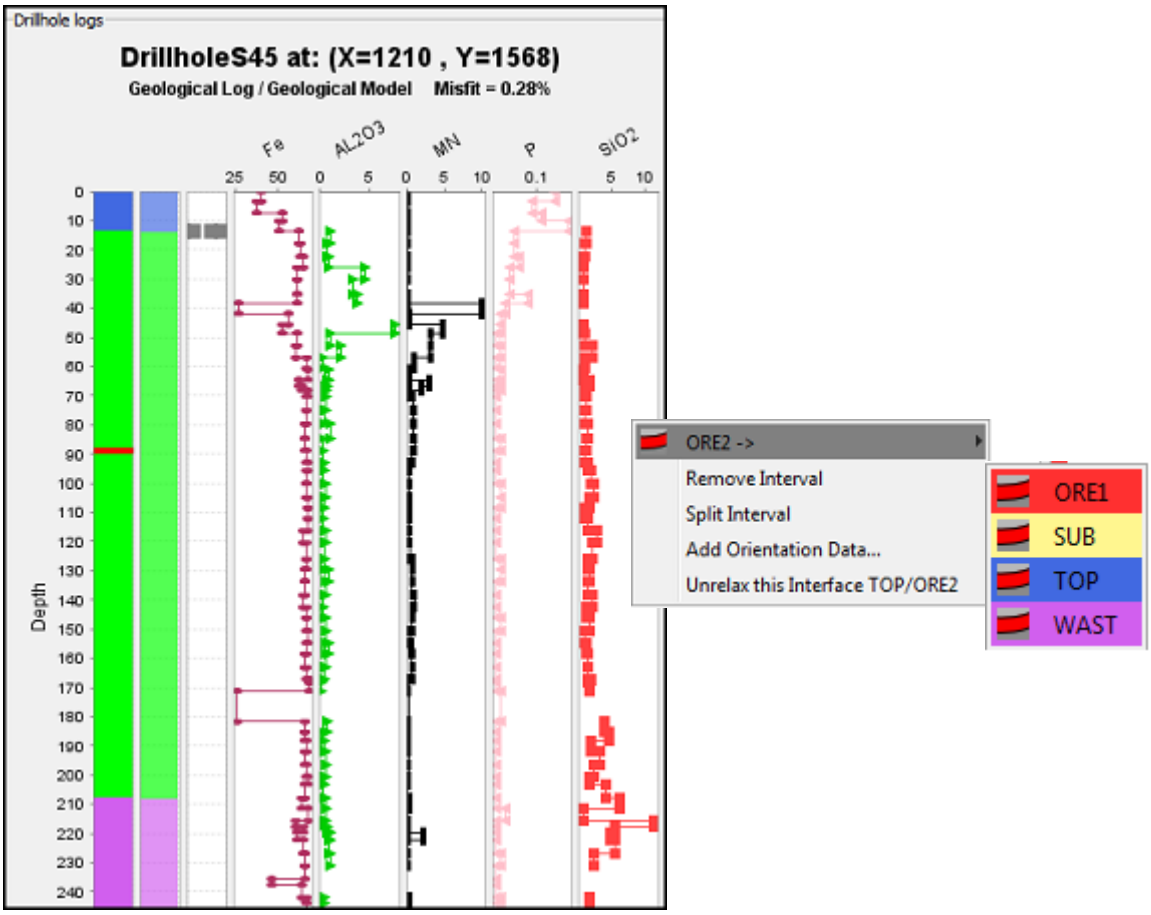
- **Menu options available when double click in the Geology, Model, User Defined or Assay Field columns are described in detail below.**
  - **Edit the Formation for a From/To Interval**
    - Double click in the Model, User Defined or Assay log columns to choose an interval. A dialog will open as shown above and a Red line will appear in the Geology column to highlight the depth/interval selected; Right click on the top dialog menu and select the new Formation ie ORE2->SUB;



    - The resulting Formation change is shown below in the first diagram describing the **Remove Interval** operation.

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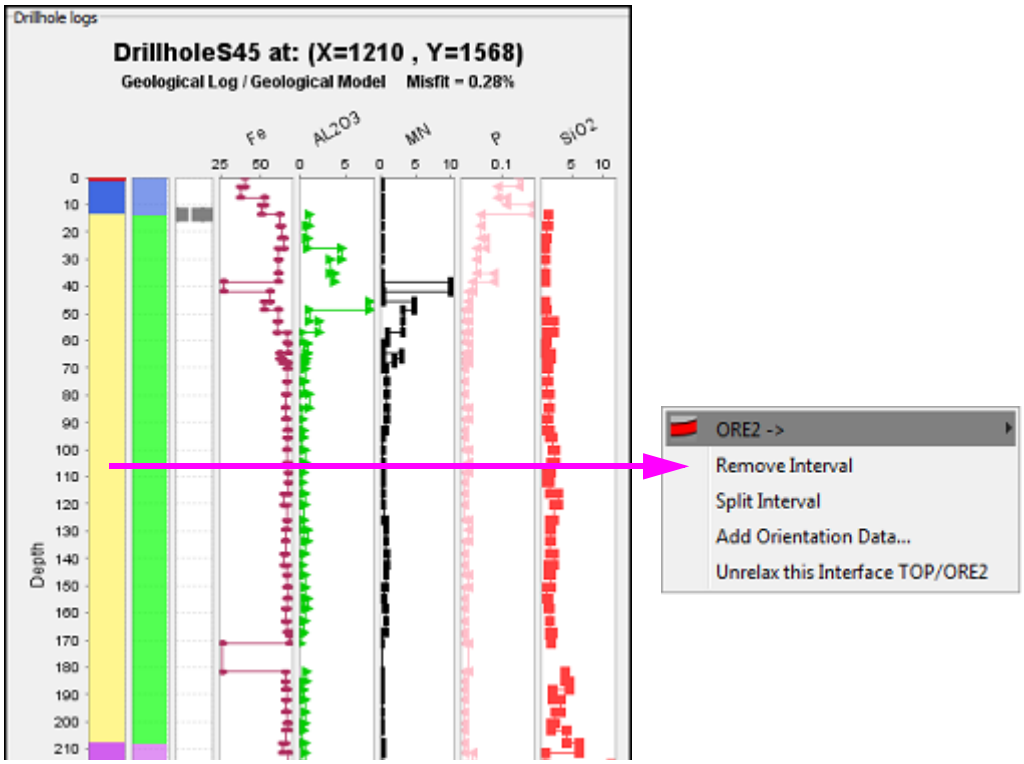
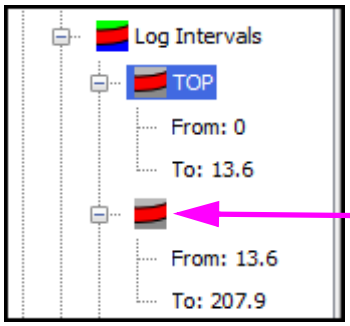
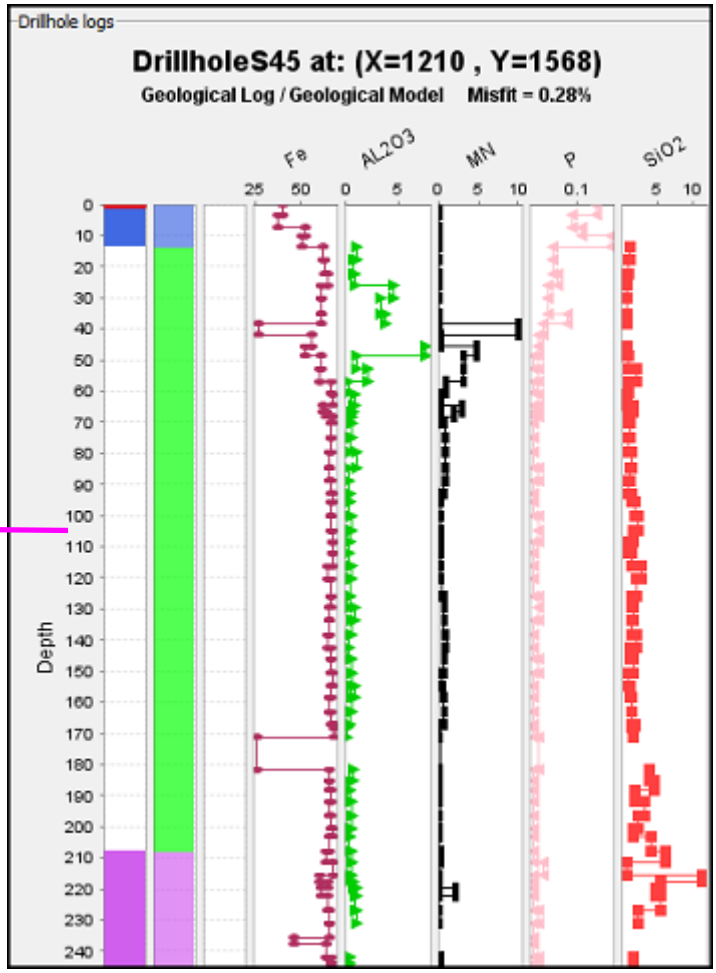
- **Remove Interval**: Double click next to the Lithology interval and select **Remove Interval**; the current Formation will be cleared from the drillhole log in both right and left panels as shown in the second diagram below







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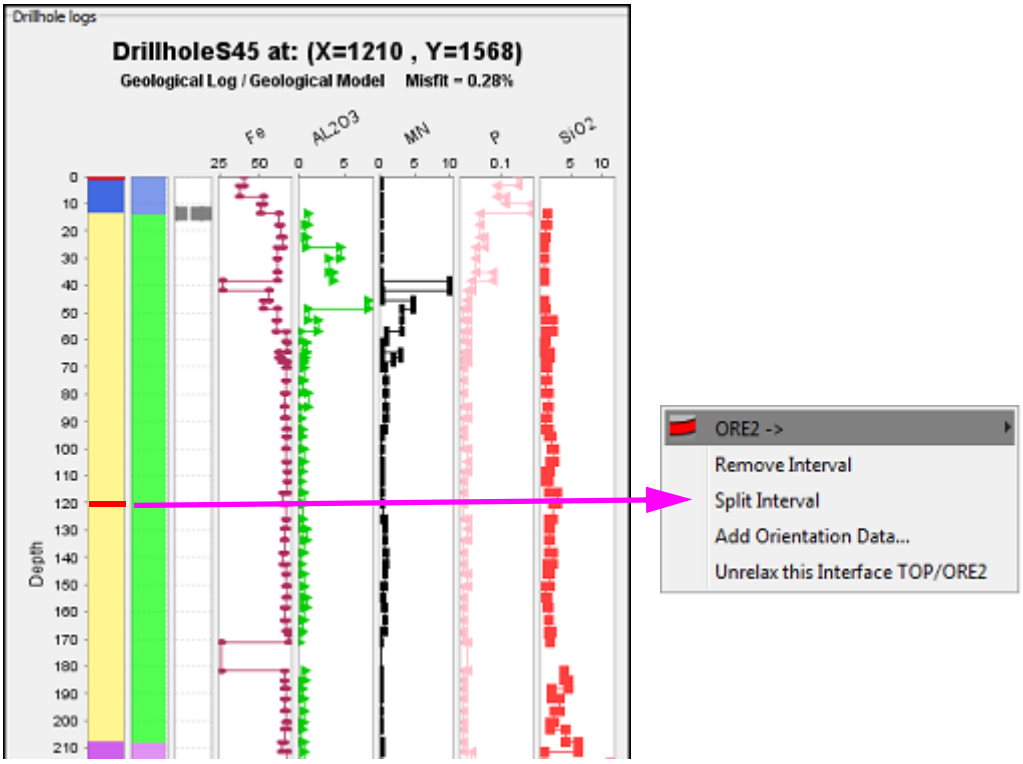
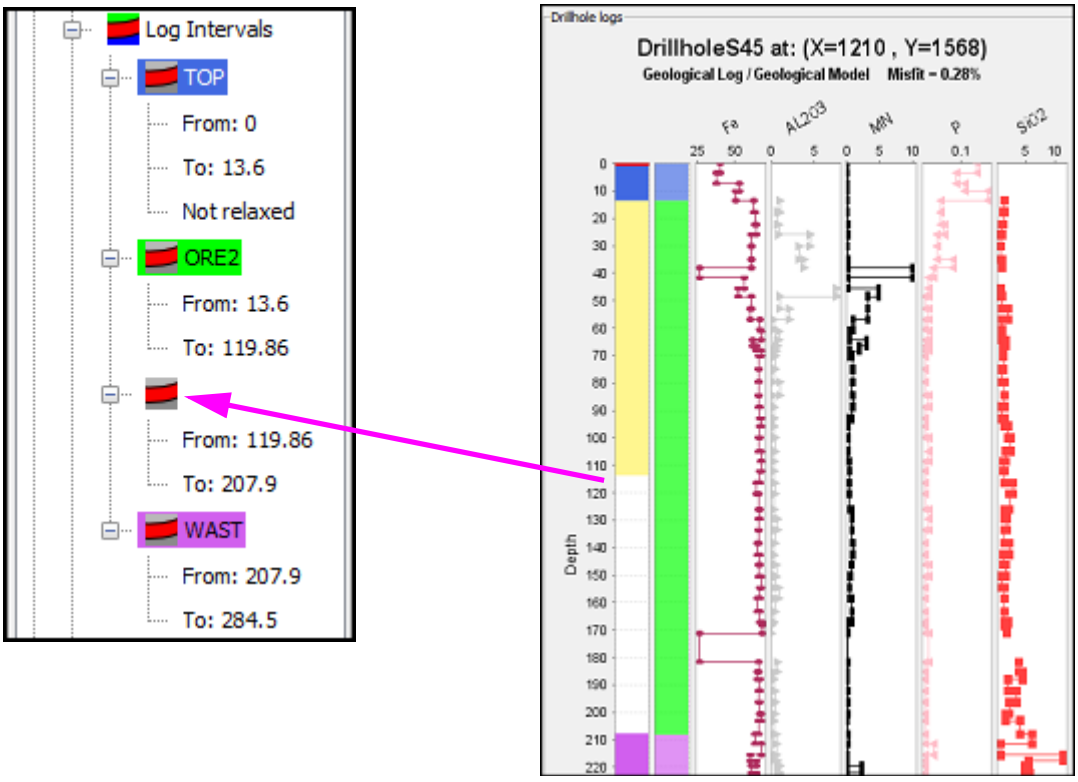
- **Split Interval**: Split an existing Lithology interval; also used to Add an interval.
  - Double click in the Model, User Defined or Assay log columns to choose an interval. A **red line** will appear in the Geology column to highlight the depth/interval selected; Double click again and select **Split Interval.** The second diagram below shows the result in both right and left panels





- In the last diagram the new formation has been set by left double

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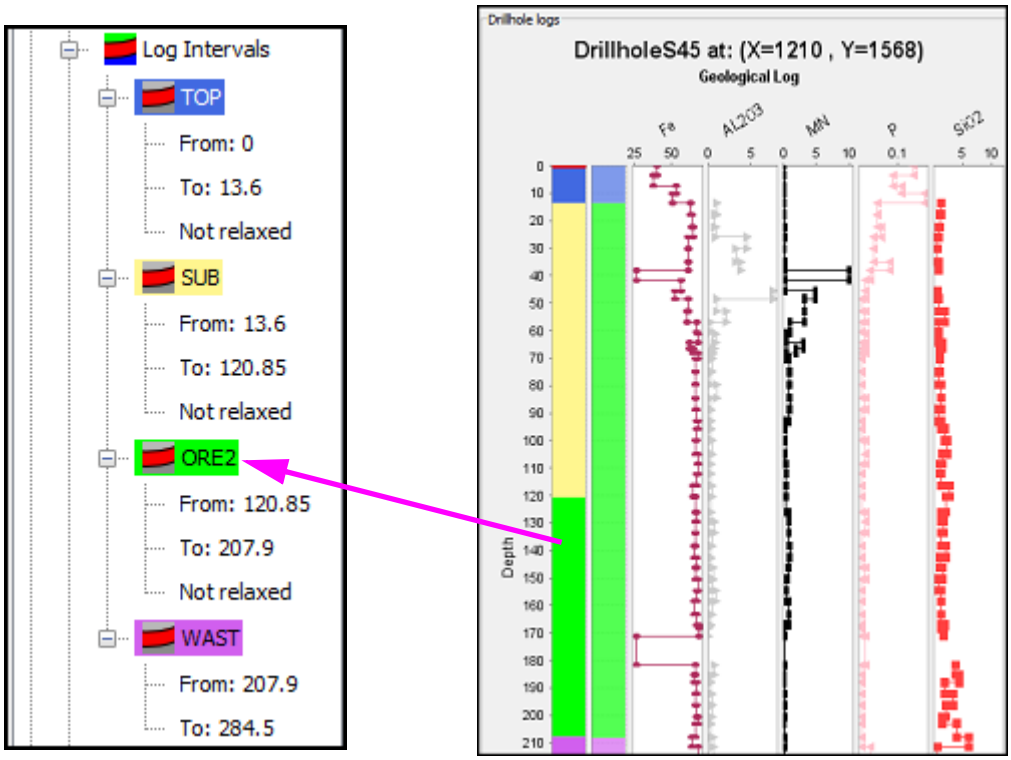
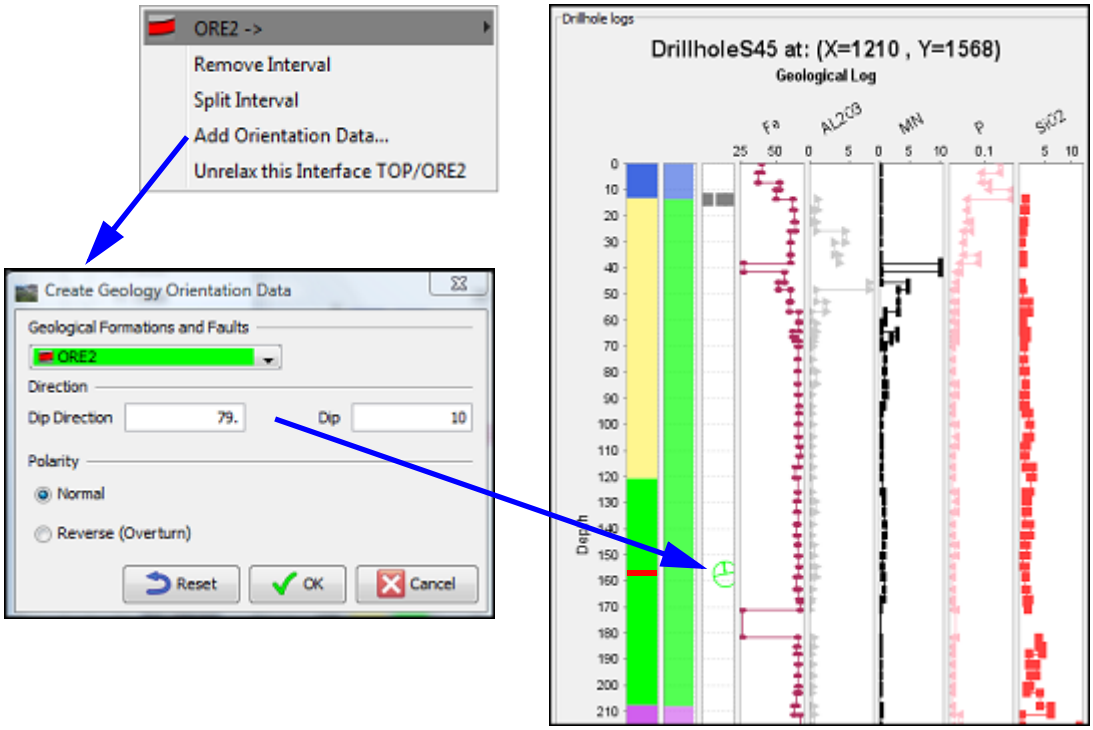
clicking in the right panel and setting the formation from the top drop down list OR by left clicking on the Interval icon in the left panel and selecting from the formation drop down list as shown previously.



- **Add Orientation Data** to the drillhole log; this is User Defined data.
  - Left double click in the **Drillhole logs** panel at the required depth and select **Add Orientation Data;** choose the Formation or Fault and set Dip, Dip Direction and Polarity



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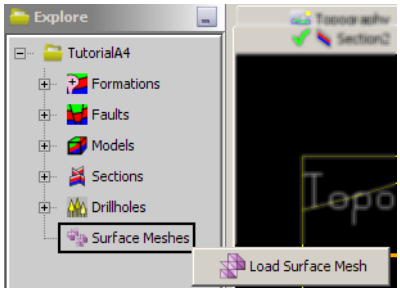
Project Explorer—Surface meshes shortcut menu

Parent topic: Project Explorer

The **Project Explorer** shortcut menu for **Surface Mesh** enables you to load a surface mesh.



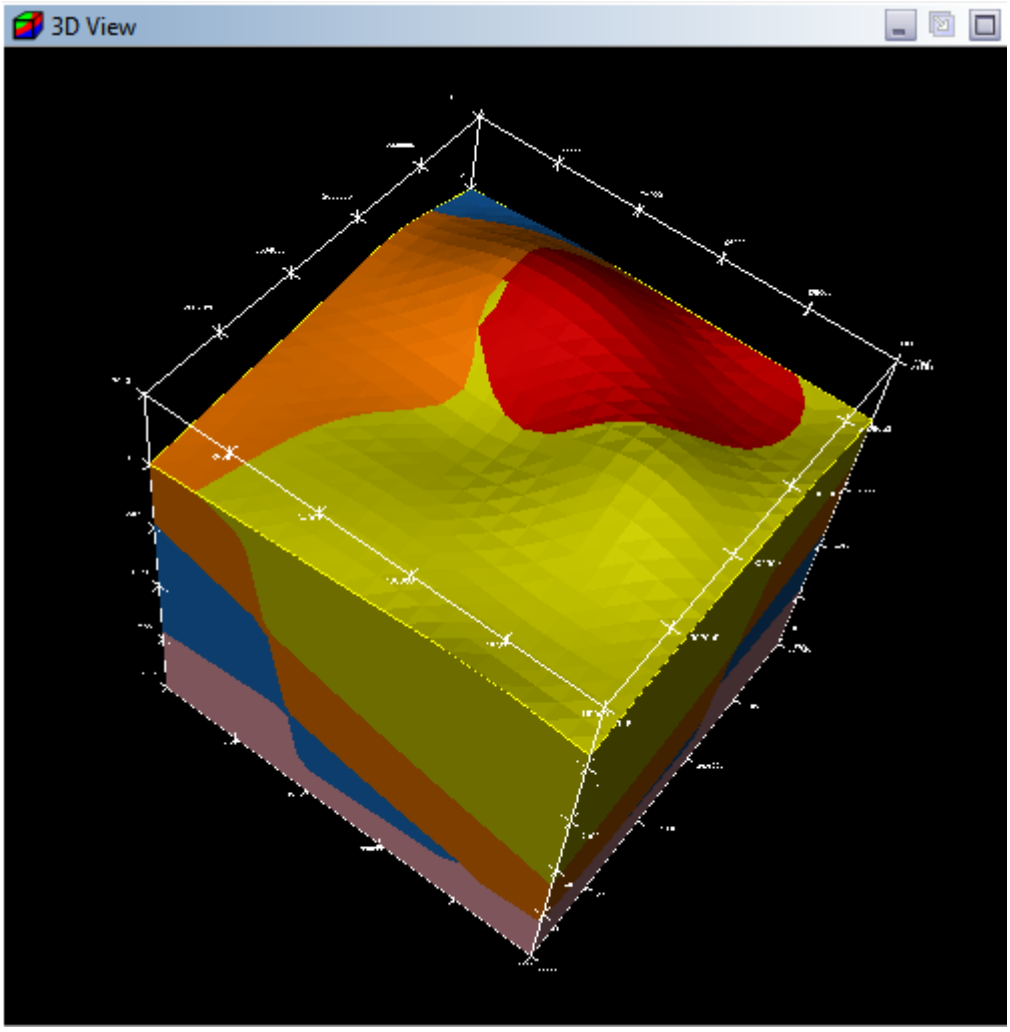
Options in this menu.

Option	Description
Load Surface Mesh	See Load Surface Mesh

3D Viewer

Parent topic: User interface overview

3D GeoModeller's **3D Viewer** enables you to visualise and work with the 3D objects in your model.



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The **3D Viewer** opens automatically at the time of project creation and when a project is loaded.

The **3D Viewer** window displays the model in 3D. You can show or hide project elements in the **3D Viewer** and pan, zoom and rotate the image.

The **3D Toolbar** is active whenever the **3D Viewer** window is selected.

You can minimise but not close the **3D Viewer** window. The **3D Viewer** window is detachable from the main GeoModeller GUI and can be moved to a separate monitor.

The controls for manipulating the 3D view are discussed in detail under the following headings.

- 3D Viewer toolbar and Mouse Operations. See 3D Controls sub menu and 3D Viewer toolbar
- Keyboard Shortcuts. See 3D Viewer Keyboard Shortcuts and Mouse Operations
- 3D Graphic Object Selection. See 3D Viewer graphic object selection
- 3D Clipping Planes. See 3D Viewer Clipping Plane Tool
- Shortcut menu operations. See 3D Viewer sub and shortcut menu.
- Shortcut menus in the **Project Explorer** (see Project Explorer)

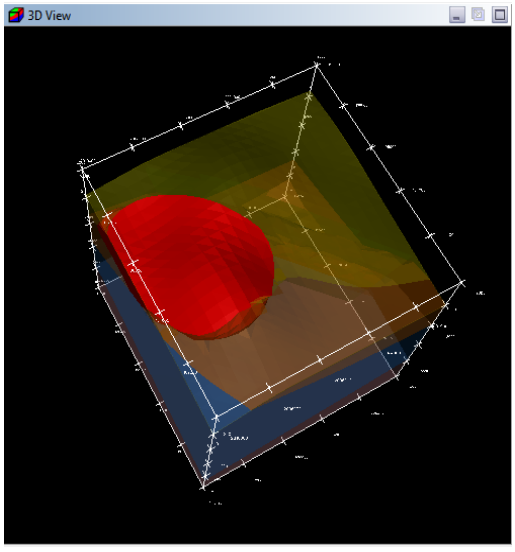
Some more recent **3D Viewer** functions are summarised below.

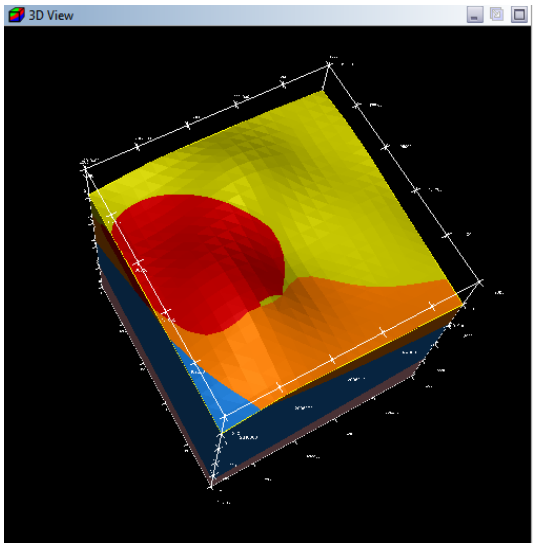
3D Viewer graphic object selection

Object selection works as follows:

- Mouse selection: **Double click** on any object in the **3D Viewer** to select and make active.

When an object is selected all other 3D objects become semi-transparent to highlight the active object. This is shown in the images below. The image on the left has the red Granite unit selected. The image on the right has no object selected.





When an object is active, the context sensitive sub-menu will change according to the type of activated object. For example, in the left and right images above the two context sensitive sub-menus will correspond to the left and right menus shown below:

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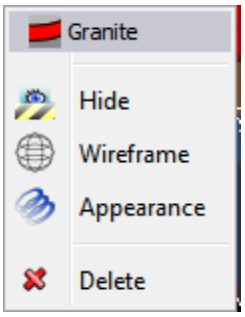
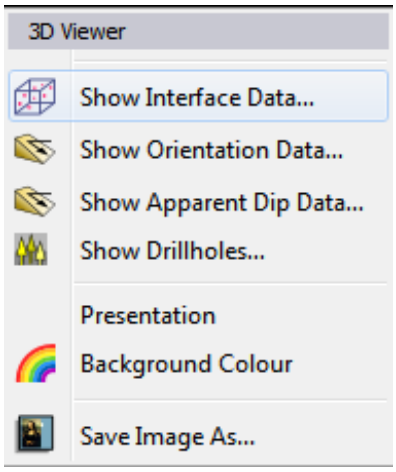


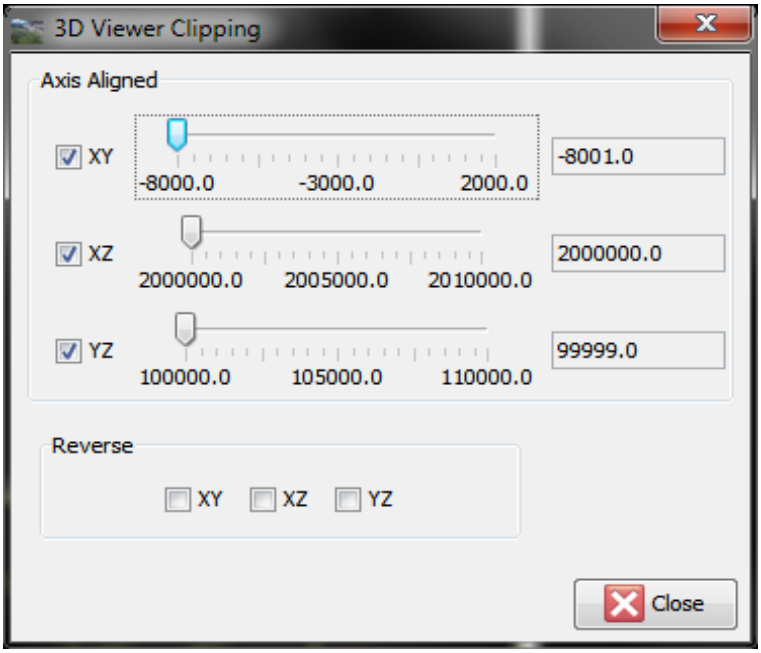


If a drillhole was active, then the sub-menu would be that of the corresponding drillhole from the Project Explorer tree. Similarly, if a section is selected and so forth.

3D Viewer Clipping Plane Tool

The 3D viewer also supports clipping planes. There are three clipping planes, one on each axis. The control dialog for the clipping parameters can be opened via the 3D viewer toolbar icon:

The clipping control parameter dialog, shown below, allows you to turn on/off the clipping planes and move them through the project volume.



NOTE: The 3D volumes produced by GeoModeller are not solid volumes. They are in fact surface shells of the geological unit and therefore contain no interior data. When clipped a hollow structure will result as shown on the *left* below. A voxet MeshGrid, shown on the *right* below, is regularly sampled and as such contains interior data. It

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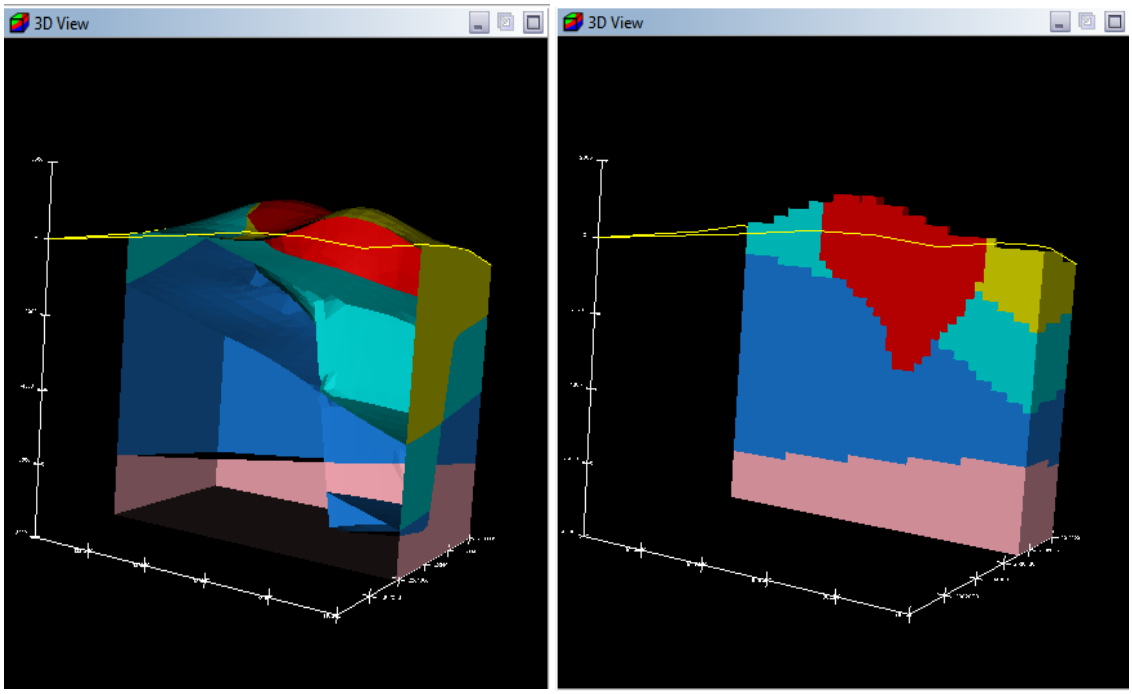
will be solid when clipped.



- **LEFT:** The 3D mesh products produced via Delaunay or MarchingCubes. These are a close approximation to the implicit model but contain no interior data. They appear hollow when clipped.
- **RIGHT:** This is a regular sampled voxet grid of the implicit model. Although less accurate than the surface shells it does provide interior data and can be clipped as a solid object.

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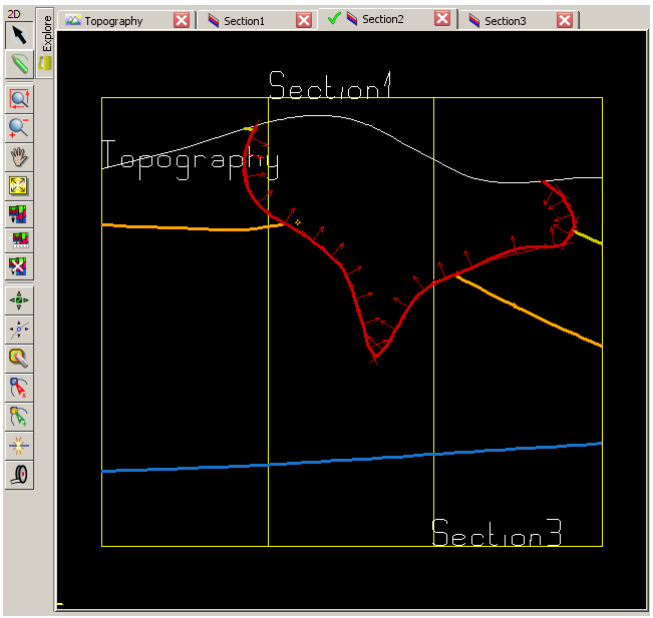
2D Viewer

Parent topic: User interface overview

The **2D Viewer** for the (topography) map view appears automatically when you define the topography for a project, and when you load a project. Other **2D Viewer**s (for other section views) appear on request.

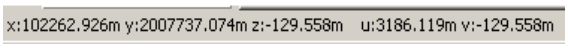


The **2D Viewer** enables you to display the elements of the map or a section, and to work in its 2D space. A **2D Viewer** opens automatically when a section is created.

The **2D Viewer** defines the two dimensional space of the map view or a section view. **Note**: The **2D Viewer** space is **not** a 'projection' onto a plane. **Rather** it is the (u, v) space which describes the map area or the section.

By default, all available sections are accessible via tabs along the bottom edge.

- The (u, v) coordinates of the current mouse location are displayed. (And also x, y, z)



- The 2D Toolbar is active whenever a 2D Viewer window is selected. Some toolbar buttons may be inactive, indicating that they are currently invalid, and so unavailable.

In this section:

- 2D Viewer toolbar
- 2D Viewer shortcut menus

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2D Viewer toolbar

Parent topic: 2D Viewer

The **2D Viewer** toolbar provides convenient access to many operations that you carry out in the **2D Viewer**

Element	Description	Icon
Select	Select objects.	
Create	Add points to the **Points list** by clicking their positions in the **2D Viewer**. See Points List	
Pan and zoom	See Pan and zoom controls	
Vertical Exaggeration	See Vertical exaggeration submenu and toolbar	
Move objects	Select and move objects. See Objects in the 2D Viewer. After selecting the objects, drag them to the required location	
Move points	Move individual points. Select this tool and drag the individual points one at a time to the place you require.	
Delete objects	Select and delete objects. See Objects in the 2D Viewer. 3D GeoModeller lists the objects to be deleted. Confirm the operation.	
Delete points	Delete individual points. Select this tool and click the point you want to delete. Confirm the operation.	
Add points	Add points within (not at the ends of) an object that has several points. Select the tool and then click the position in or near the object to add the point.	
Split apart	Split an object into two. Select this tool and then click the object between the points where you want to split it.	
Tape measure	See Tape Measure	

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Objects in the 2D Viewer

Parent topic: 2D Viewer toolbar

You can perform a number of operations on selected objects in the 2D Viewer

An object can be

- An orientation point
- A set of geology contact points
- A set of axial surface points
- A set of hinge line points
- A fault

>> *To select an object*

1 Point to it. 3D GeoModeller changes its colour to white

>> *To select several objects for moving or deleting*

1 From the 2D Viewer toolbar select the operation (Move object or Delete object) that you require.

2 In the 2D Viewer drag a rectangle to completely enclose the objects you want to select.

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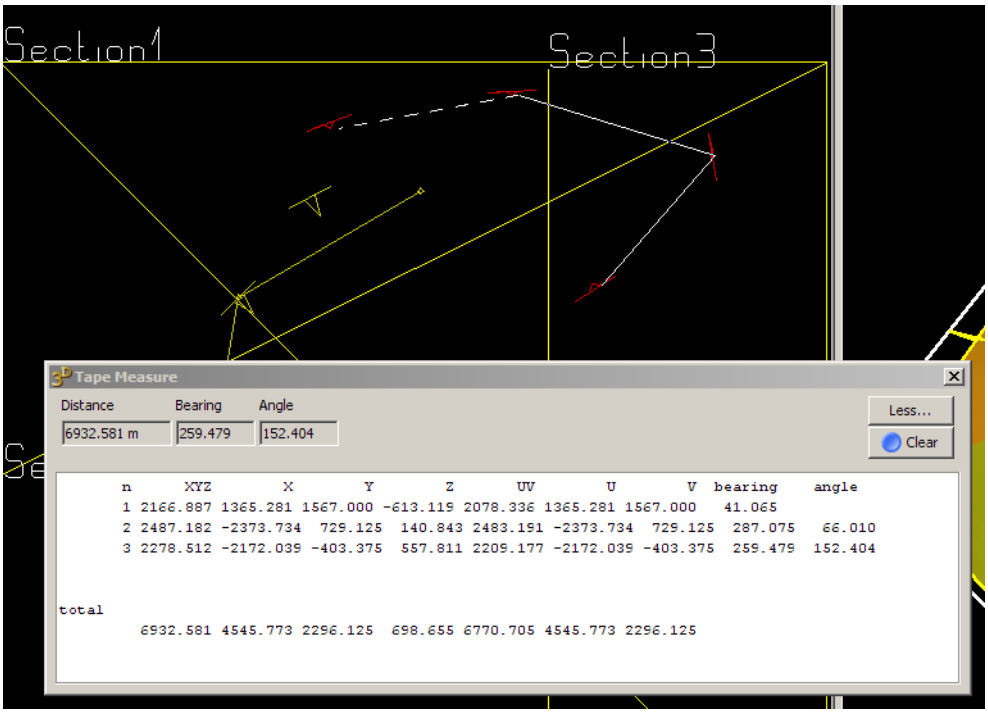
Tape Measure

Parent topic: 2D Viewer toolbar

The **Tape Measure** enables you to measure distances and angles in the **2D Viewer**.



Note the caution about **xyz** and **uv** measurements in steep terrain. See Status bar and conventions for spatial coordinates.

Operations that use this window

- Using the Tape Measure

Options in this window.

Option	Description
Distance, Bearing, Angle	Location of the current mouse position relative to the last point clicked
More, Less	To view all data from your measurements, choose **More**. To view only the distance, bearing and angle, choose **Less**.
Text area	The text area shows the coordinates of the points you have clicked and the angles and distances between them. 3D GeoModeller sets the coordinates of the first point you clicked as zero. For details of the notation see Status bar and conventions for spatial coordinates.
Clear	Clear the current path and data from the **Tape Measure**

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2D Viewer shortcut menus

Parent topic: 2D Viewer

For the main **2D Viewer** shortcut menu, see 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus.

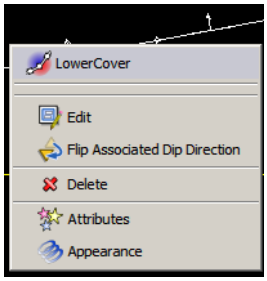
You can view or change properties of the objects that you see in the **2D Viewer**:

- Geology data —2D Viewer—Geology data shortcut menu
- Orientation data —2D Viewer—Geology orientation data shortcut menu
- Faults —Project Explorer and 2D Viewer—Faults shortcut menus
  (Not available from 2D Viewer: Create or Edit Faults dialog box)
- Drillholes —Project Explorer and 2D Viewer—Drillholes shortcut menus.
- Axial surfaces —2D Viewer—Axial surface shortcut menu
- Axial surface orientation data —2D Viewer—Axial surface orientation data shortcut menu
- Hinge lines —2D Viewer—Hinge line shortcut menu

2D Viewer—Geology data shortcut menu

Parent topic: 2D Viewer shortcut menus

The geology data shortcut menu appears when you right click a set of geology data that is visible in the **2D Viewer**. It enables you to edit and configure the set of data.



Options in this menu.

Option	Description
Edit	See Create (or Edit) Geology Data dialog box
Flip Associated Dip Direction	*(If the data has associated orientation data that is not Orthogonal)* Reverse the order of points. This reverses the automatically calculated orientation data. See Create (or Edit) Geology Data dialog box for further explanation.
Delete	Delete the object or data
Attributes	Edit the attributes of the associated formation. See Create or Edit Geology Formations dialog box
Appearance	Edit the appearance of the associated formation. See Appearance of objects dialog box family

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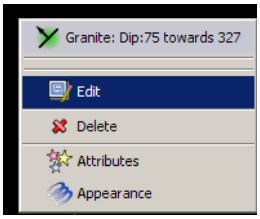
2D Viewer—Geology orientation data shortcut menu

Parent topic: 2D Viewer shortcut menus

The geology orientation data shortcut menu appears when you right click a geology orientation data point that is visible in the **2D Viewer**. It enables you to edit and configure data point.



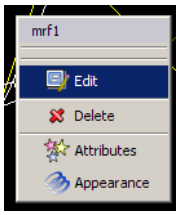
Options in this menu.

Option	Description
Edit	See Create (or Edit) Geology Orientation Data dialog box
Delete	Delete the object or data
Attributes	Edit the attributes of the associated formation. See Create or Edit Geology Formations dialog box
Appearance	Edit the appearance of the associated formation. See Appearance of objects dialog box family

2D Viewer—Axial surface shortcut menu

Parent topic: 2D Viewer shortcut menus

The axial surface data shortcut menu appears when you right click a set of axial surface data that is visible in the **2D Viewer**. It enables you to edit and configure the set of data.



Options in this menu.

Option	Description
Edit	See Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box
Delete	Delete the object or data
Attributes	See Axial Surface Attributes dialog box
Appearance	See Appearance of objects dialog box family

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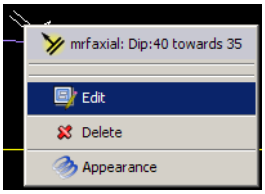
2D Viewer—Axial surface orientation data shortcut menu

Parent topic: 2D Viewer shortcut menus

The axial surface orientation data shortcut menu appears when you right click an axial surface orientation data point that is visible in the **2D Viewer**. It enables you to edit and configure the point.



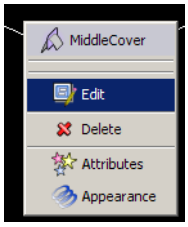
Options in this menu.

Option	Description
Edit	See Create (or Edit) Axial Surface Orientation Data dialog box
Delete	Delete the object or data
Appearance	Edit the appearance of the associated axial series. See Appearance of objects dialog box family

2D Viewer—Hinge line shortcut menu

Parent topic: 2D Viewer shortcut menus

The hinge line data shortcut menu appears when you right click a set of hinge line data that is visible in the **2D Viewer**. It enables you to edit and configure the set of data.



Options in this menu.

Option	Description
Edit	See Create (or Edit) Hinge Line Data dialog box
Delete	Delete the object or data
Attributes	Edit the attributes of the associated formation. See Edit Geological Formation Attributes dialog box
Appearance	Edit the appearance of the associated formation. See Appearance of objects dialog box family

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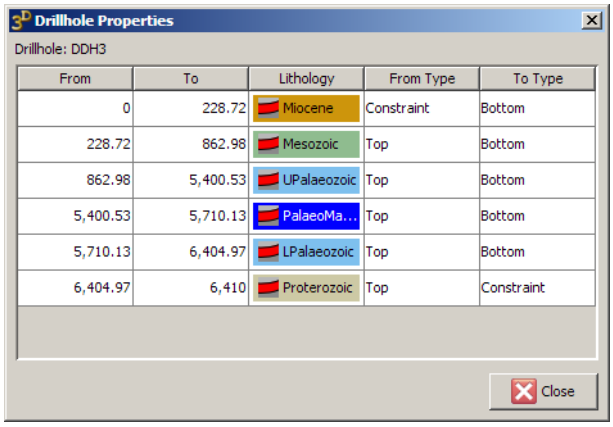
Drillhole properties dialog box

Parent topic: 2D Viewer shortcut menus

The **Drillhole Properties** dialog box appears when you choose **Properties** from a drillholes shortcut menu.



Controls in this dialog box

Control	Purpose
From, To	**From** is the distance down the drillhole from the collar to the start of the interval. **To** is the distance down the drillhole from the collar to the end of the interval
Lithology	The formation name for the interval
From, To Type	Nature of the **From** or **To** data. **Top**: Top contact of formation **Bottom**: Bottom contact of formation **Constraint**: Not a top or bottom contact of a formation

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Points List

Parent topic: **User interface overview**

In this section:

- Introduction to the Points List
- Points List toolbar (docked)
- Points List Editor (floated)
- Importing GIS and other binary located data
- Points table
- How the Points List coordinates with the 2D Viewer
- Editing geological data with the Points List

In other sections:

- Points List Visualisation dialog box
- Point Acquisition Parameters dialog box

Introduction to the Points List

Parent topic: **Points List**

The **Points List** stores a set of points associated with a 2D section.

Loading the Points List

You can load points into the **Points List** in any of the following ways:

- Clicking new points in the **2D viewer**
- Importing new points from a file containing Geographical Information Systems (GIS) data or other binary located data
- Editing a set of points in the 2D section. 3D GeoModeller makes a copy of them in the **Points List**.
- Entering new point data into the **Points Table**

Points list operations

The **Points List** enables you to:

- Input new data by clicking locations in the **2D viewer**
- Import Geographical Information Systems (GIS) data or other binary located data, such as INTREPID vector datasets.
- Enter new data or edit existing data directly in a table.
- Create a section by defining it by its trace
- Create or edit geology and structural data—Geology contact and orientation data, axial surface contact and orientation data, hinge line data
- Control the rate of display rendering for dense imported data
- Generate point coordinates to use as inputs for subsequent dialog boxes.

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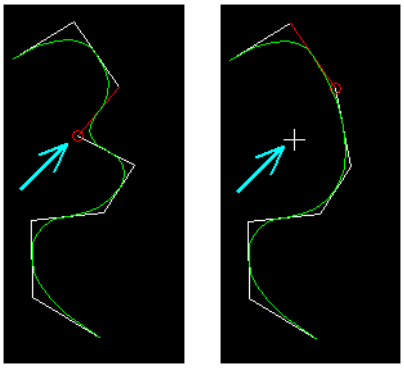
Notes about the Points List:

- The Points List contents are not part of the geology observations (though they may be a copy of an observation or set of observations). They are simply a list of points.
- They are linked together in an order that you can reverse or rearrange. The order affects:
  - The way 3D GeoModeller displays the points
  - The way 3D GeoModeller converts them or some of them to observation points on the section
- In the **2D Viewer** display:
  - 3D GeoModeller shows line segments between points in the display but does not use them when computing the geological model.
  - The **Points List** has a 'current point' (or 'selected point'), shown by the red circle.

  See How the Points List coordinates with the 2D Viewer for details.
- To insert new points, navigate to the required location, then click to insert after the 'current selected point'.
- You cannot move points directly. To 'move' a point, insert a new point and then find and delete the 'incorrect' point.



- In general, when the points in the Points List have been used for some purpose, such as being used to enter geology observations, 3D GeoModeller resets the Points List to 'empty' (those points that were in the edit layer are now cleared away). Otherwise, to clear the list-use the trash can icon

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Points List toolbar (docked)

Parent topic: Points List

The **Points List** toolbar (docked) is one of the toolbars at the top of the 3D GeoModeller window. You can use it to navigate through the points, delete them singly, reverse their order in the list or delete them all.

You can view **Points List** operations in the **2D Viewer**. See How the Points List coordinates with the 2D Viewer.

You can also detach (float) the toolbar. When you float it, it becomes the **Points List Editor**. See Points List Editor (floated).

Controls in this toolbar

Operation	Description	Tool
Go back 10 points		
Go to the previous point		
Go to the next (following) point		
Go forward 10 points		
Reverse the order of the points in the list. See Editing geological data with the Points List to find out when you would want to do this.		
Delete the current point		
Delete all points		
Float the points list editor	When you float the **Points List** toolbar, it becomes the **Points List Editor**. See Points List Editor (floated).	

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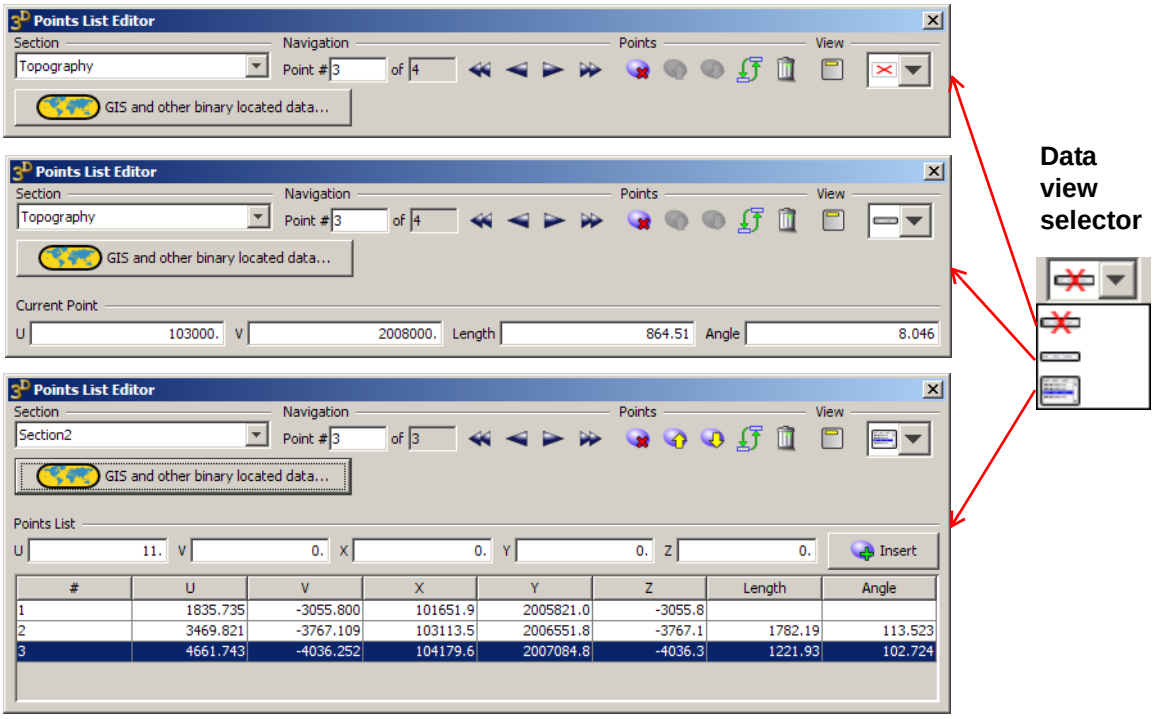
Points List Editor (floated)

Parent topic: Points List

When you float the **Points List** toolbar, it becomes the **Points List Editor**. You can use this for importing points into the points list and for editing its contents.

You can view **Points List** operations in the **2D Viewer**. See How the Points List coordinates with the 2D Viewer.

You can expand and contract the **Points List Editor** to show the coordinates of the currently selected point or the **Points Table** or neither. Use the **Data View Selector**.


Points List Editor
Section
Navigation
Points
View
Topography
Point # 3 of 4
GIS and other binary located data...
Current Point
U 103000. V 2008000. Length 864.51 Angle 8.046
Section2
Point # 3 of 3
Points List
U 11. V 0. X 0. Y 0. Z 0.
Insert
U V X Y Z Length Angle
1 1835.735 -3055.800 101651.9 2005821.0 -3055.8
2 3469.821 -3767.109 103113.5 2006551.8 -3767.1 1782.19 113.523
3 4661.743 -4036.252 104179.6 2007084.8 -4036.3 1221.93 102.724
Data view selector

Controls in the Points List Editor

Operation	Description	Tool
Section	Current section associated with the contents of the **Points List**. Select from the drop down list. 3D GeoModeller empties the points list when you select a different section	
Navigation	The selected (current) point in the **Points List**. To select a different point, enter a point number and press ENTER or use the arrow buttons on the **Points List Toolbar**.	
Points list toolbar (docked) controls	 For information about the toolbar controls, see Points List toolbar (docked)	

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Operation	Description	Tool
Move up, **Move down**	Move selected points up or down in list. You can select several points in the conventional Windows way by holding down CTRL and clicking individual points or holding down SHIFT to select a range of points	
Dock	When you dock the **Points List Editor**, it becomes the **Points List** toolbar. See Points List toolbar (docked)	
Data view selector	Sections of the **Points List** to display: • Hide current point and points table • Show current point coordinates but not points table • Show text boxes, **Insert** button for entering a new point and the **Points table**	
GIS and other binary located data	Show or hide the **GIS and other binary located data** controls. See Importing GIS and other binary located data.	
Current point	*(When current point only is selected, not points table)* Coordinates of the currently selected point in the **Points List**. This is a display of values only. You cannot edit the current point in this mode.	
Points list	*(When the points table is selected and visible)* Enter coordinates of a new point in the boxes provided. Choose **Insert** to add the point after the current point. Select or edit point coordinates in the **Points Table**. See Points table	

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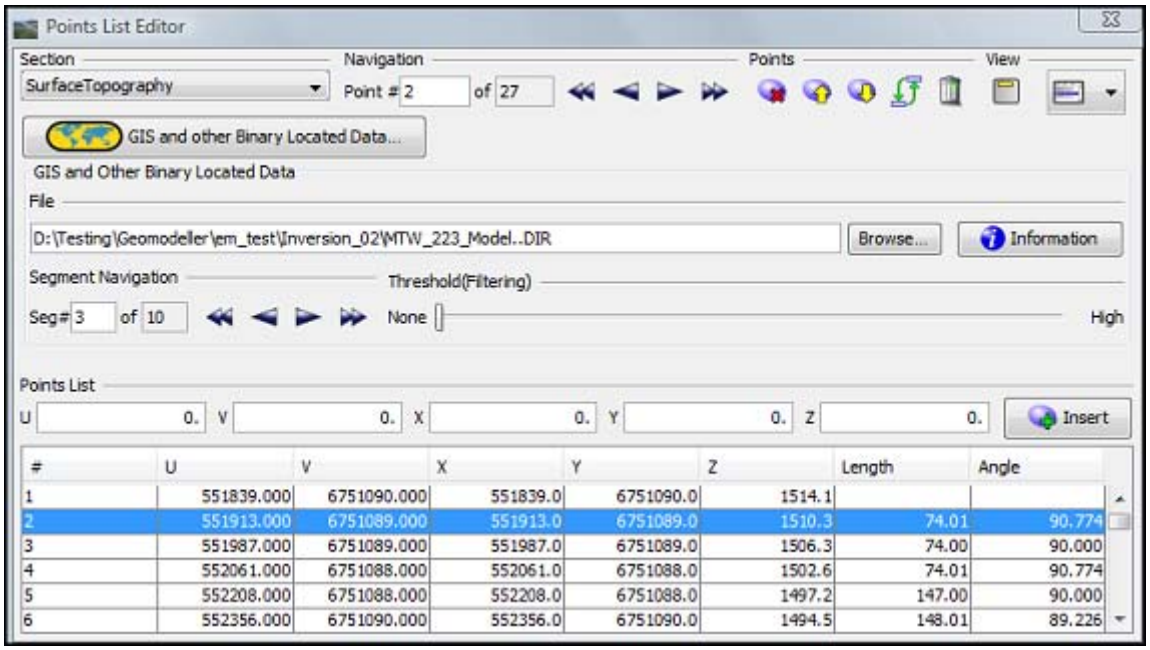
Importing GIS and other binary located data

Parent topic: Points List

You can import binary located data into the **Points List** and create sets of data points in your project. 3D GeoModeller supports at least the following formats. Contact our support service for information about other formats:

- Arc Shape
- MapInfo TAB
- MapInfo MIF/MID
- ASCII CSV
- INTREPID ..DIR databases
- Geosoft GDB databases

3D GeoModeller can only load one segment from the file at a time into the **Points List**.



Before you import GIS data, ensure that the data is geologically relevant to the contact or surface to which you are importing, or that you can eliminate irrelevant data by rejecting data segments during the import process. If necessary, prepare the GIS data beforehand.

Some imported data may have a higher density than you need for creating a geological model, so 3D GeoModeller can intelligently sample this data for inclusion. It samples at different rates depending on the shapes of contact surfaces, sampling more points where the shapes change. Often you require as little as 10% to construct a satisfactory geological model.

If the import data is geodetic or has a specified datum and projection, 3D GeoModeller automatically converts it to the datum and projection of the project.

3D GeoModeller ignores data that is outside the boundaries of your project.

After you import the data, 3D GeoModeller displays a summary report.

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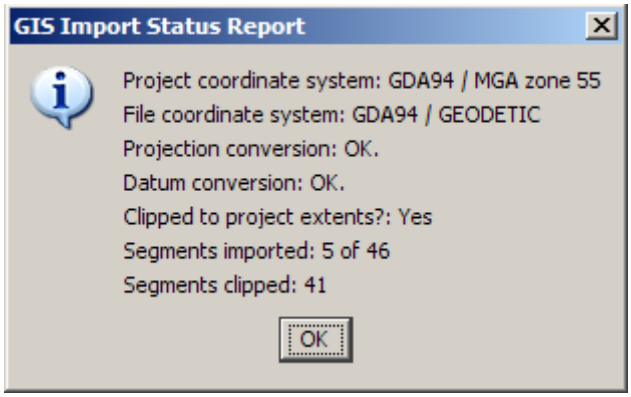
GIS Import Status Report
Project coordinate system: GDA94 / MGA zone 55
File coordinate system: GDA94 / GEODETIC
Projection conversion: OK.
Datum conversion: OK.
Clipped to project extents?: Yes
Segments imported: 5 of 46
Segments clipped: 41
OK

Controls in the GIS and other binary located data area

Operation	Description	Tool
GIS and other binary located data	Show or hide the **GIS and other binary located data** controls	
File, **Browse**	Path and filename of selected GIS or other binary located import file. Choose **Browse** to select a file.	
Information	Display attribute data for the current segment (line or polygon) of the loaded file.	
Segment navigation	Select a segment of the file to examine. 3D GeoModeller loads one segment at a time into the **Points List** and displays it in the **Points Table** and the **2D Viewer**. 3D GeoModeller shows the selected segment and the number of segments available. To select a different segment, enter a segment number and press ENTER.	
	Go back 10 segments	
	Go to the previous segment	
	Go to the next (following) segment	
	Go forward 10 segments	
Threshold (Filtering)	Control the density of the data available in the **Points List**. Select **None** to include all data. As you slide the control towards **High**, 3D GeoModeller samples fewer data points for inclusion in the **Points List**.	

Points table

Parent topic: Points List

The points table in the **Points List Editor** provides information about the contents and state of the **Points List** and enables you to edit the data.

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#	U	V	X	Y	Z	Length	Angle
1	1835.735	-3055.800	101651.9	2005821.0	-3055.8		
2	3469.821	-3767.109	103113.5	2006551.8	-3767.1	1782.19	113.523
3	4661.743	-4036.252	104179.6	2007084.8	-4036.3	1221.93	102.724
4	4769.821	-3767.109	104113.5	2006551.8	-4767.1	782.19	133.523

For an explanation of the coordinates, see Status bar and conventions for spatial coordinates.

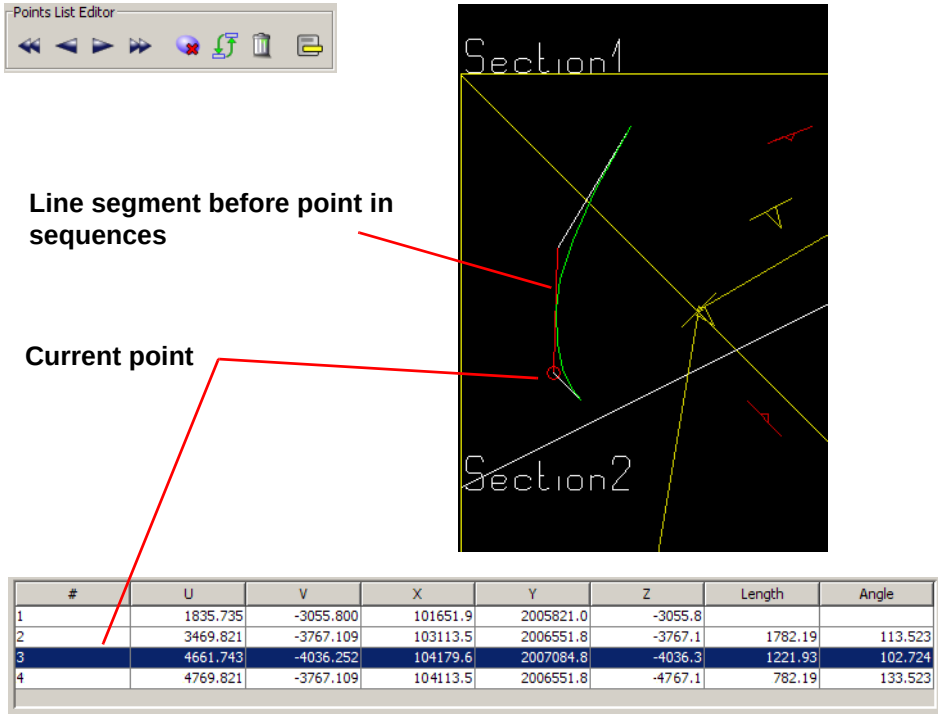
You can edit the coordinate values **U**, **V**, **X**, **Y**, **Z**. 3D GeoModeller calculates the **Length** and **Angle** from the coordinate values.

You can view **Points List** operations in the **2D Viewer**. See How the Points List coordinates with the 2D Viewer.

How the Points List coordinates with the 2D Viewer

Parent topic: Points List

The **Points List Editor** always has a current point. In the floated **Points List Editor** it is highlighted in the table. You can use the navigation buttons in the **Points List toolbar** to select different points to be the current point. In the **2D Viewer** the current point appears as a red circle and the path from the previous point to it appears as a red line.



#	U	V	X	Y	Z	Length	Angle
1	1835.735	-3055.800	101651.9	2005821.0	-3055.8		
2	3469.821	-3767.109	103113.5	2006551.8	-3767.1	1782.19	113.523
3	4661.743	-4036.252	104179.6	2007084.8	-4036.3	1221.93	102.724
4	4769.821	-3767.109	104113.5	2006551.8	-4767.1	782.19	133.523

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Editing geological data with the Points List

Parent topic: Points List

The **Points List** works with the 3D GeoModeller point data editing dialog boxes.

If you are creating a new set of data points, the **Points List** supplies the point locations that make up this new set.

If you start editing a set of data points, 3D GeoModeller loads them into the **Points List**. As well as editing the properties of the data and being able to move the points in the **2D Viewer**, you can edit them in the **Points List**.

In a **Create** or **Edit** dialog box, you can check or clear the **Automatically Re-edit** check box. It has the following effect:

Setting	Effect
Checked	When you choose **Create** or **Edit**, 3D GeoModeller retains the contents of the **Points List** so you can perform further operations on the points.
Clear	When you choose **Create** or **Edit**, 3D GeoModeller clears the **Points List**.

For more information about the **Points List** and orientation data, see Orientation data plot symbols.

The **Points List** works with the following data creation and editing dialog boxes:

- Create (or Edit) Geology Data dialog box
- Create (or Edit) Geology Orientation Data dialog box
- Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box
- Create (or Edit) Axial Surface Orientation Data dialog box
- Create (or Edit) Hinge Line Data dialog box

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3D GeoModeller main menus

Parent topic: **User interface overview**

3D GeoModeller has the following main menus:

- Project menu, Project toolbar and dialog boxes
- Section menu, toolbar and dialog boxes
- Geology menu and dialog boxes
- Model menu, toolbar and dialog boxes
- Geophysics menu and dialog boxes
- Import menu and dialog boxes
- Export menu and dialog boxes
- View menu and dialog boxes
- Window menu and dialog boxes
- Help menu and dialog boxes

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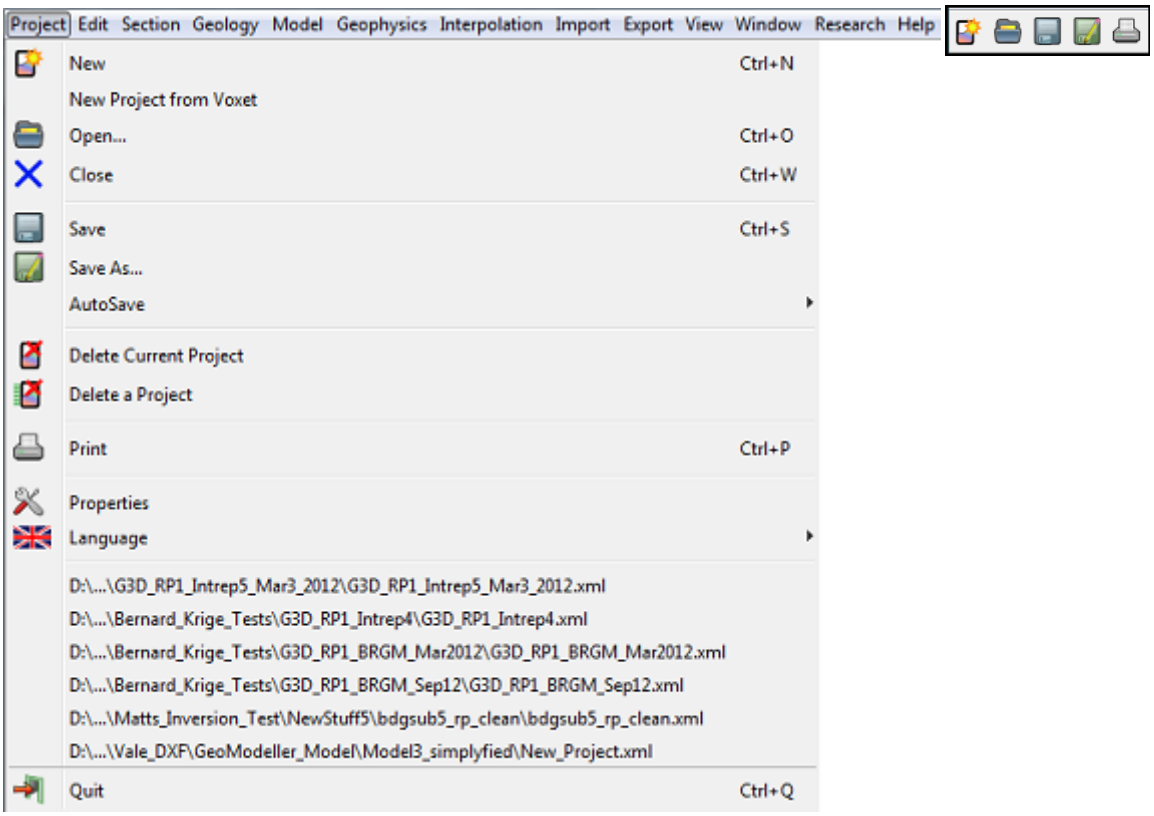
Project menu, Project toolbar and dialog boxes

Parent topic: 3D GeoModeller main menus

Use the **Project** menu to manage 3D GeoModeller data at the project level. The **Project** toolbar contains frequently used options from the **File** menu.



See the following table for an overview of the **Project** menu. The table also shows the icons from the **Project** toolbar.

Option	Description	Tool	Keys
New	Create new project. See Create new project.		CTRL+N
New Project from Voxet	Create a new project from a G0CAD voxet. See New Project from Voxet.		
Open	Open an existing project		CTRL+O
Close	Close current project		CTRL+W
Save	Save the current project with its current name, replacing the previous version. If it is a new project, 3D GeoModeller uses **Save As**. See Save a project (and Save As ...).		CTRL+S
Save As	Save the current project with a new name.		CTRL+ SHIFT+S
Autosave > Recover Saved Project	Recover a previous version of the project that 3D GeoModeller automatically saved. See Automatic Saves dialog box.		
Autosave > Preferences	Set autosave preferences. See Autosave Preferences dialog box.		

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Option	Description	Tool	Keys
Delete Current Project	Delete the current project		
Delete a project	Delete a project that is not the current project		
Print	Print the contents of a viewer. See Print Viewer dialog box.		CTRL+P
Properties	View or edit the properties of the current project. See Project Properties dialog box.		
Language	Select a language for the user interface		
Quit	Exit from 3D GeoModeller		CTRL+Q
	Exit without asking whether you want to save the project	CTRL+SHIFT+Q	

Create new project

Parent topic: **Project menu, Project toolbar and dialog boxes**

When you create a new project, 3D GeoModeller displays the **Project Properties** dialog box. See Project Properties dialog box.

New Project from Voxet

Parent topic: **Project menu, Project toolbar and dialog boxes**

You can create a new 3D GeoModeller project from an external GoCAD voxet. The GoCAD voxet must have a Lithology field and ideally header information carrying the formation names and colours. See Create New Project from Voxet.

Save a project (and Save As ...)

Parent topic: **Project menu, Project toolbar and dialog boxes**

Main menu: **Project > Save** (or **Save As ...**)

Your current work in a 3D GeoModeller session—all new data-entries, edits, model computation, plotting of model results—reside in memory (RAM). To save your project to hard disk, use **Project > Save** (or **Project > Save As ...**).

To save a new project, or make a new version of a project, use **Save As**.

To save changes to an already saved open project, use **Save**.

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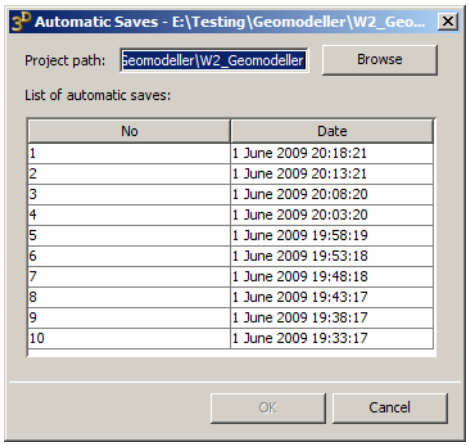
Automatic Saves dialog box

Parent topic: Project menu, Project toolbar and dialog boxes

3D GeoModeller can automatically save your work every few minutes.

For instructions see Recovering a saved project

The Automatic Saves dialog box appears when you choose **File > Autosave > Recover**. It enables you to reload an automatically saved version of your project.



Controls in this dialog box

Control	Purpose
Project path	Path of your 3D GeoModeller project
List of automatic saves	List of copies of your project that 3D GeoModeller has automatically saved

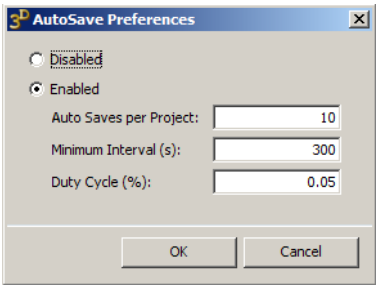
Autosave Preferences dialog box

Parent topic: Project menu, Project toolbar and dialog boxes

The Autosave function is designed to save your project at regular time intervals while it is being worked on. You can select the time interval between saves and the maximum number of saves to be stored.

The objective is to enable you to restore a project to a previously saved state if:

- Some data points or lines have been deleted or constructed or imported or you decide that recent work was in error.
- The application has crashed after you have been working on a project for some time without saving the project.
- A computer or network failure has occurred.



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Controls in this dialog box

Option	Description
Enabled or Disabled	You can enable or disable Autosave using the toggle switch. On installation the Autosave default is disabled. Once Autosave is enabled it will remain on until you choose to disable it. Autosave remembers its new default settings for multiple invocations of 3D GeoModeller not just the current session. The project autosaves are stored beneath the current project in a folder called Autosave. If you are is working on a fresh project that has not been saved and an Autosave is triggered by the timer, 3D GeoModeller asks you to save the project first.
Auto Saves per Project	You can choose the maximum number of saved copies of a project. The default is 10. This enables you some control over the amount of disk storage consumed. The choice will be somewhat dependent on the Minimum time interval chosen in the next option. Once the maximum number of project saves is reached 3D GeoModeller overwrites the autosaved project copies, starting with the oldest.
Minimum Intervals	You can select the time interval between each autosave in seconds. The default time interval is 60 seconds.
Duty Cycle (%)	You can adjust the Duty Cycle so that the Autosave process does not consume too much time and interfere with work productivity. You can think of the Duty Cycle as the maximum proportion of work time the Autosave process will use. The smaller the number the less impact Autosave will have but it might mean that the project will be saved less often than the minimum time interval. This is best illustrated with some simple examples: • If the last autosave took 60 secs, the minimum interval is set to 300 secs and the default Duty Cycle is 5% then the next Autosave will take place in: Max(60/0.05, 300) or Max(1200, 300) = 1200 secs • If the last autosave took 2 secs, the minimum interval is set to 300 secs and the default Duty Cycle is 5% then the next Autosave will take place in Max(2/0.05, 300) or Max(40, 300) = 300 secs

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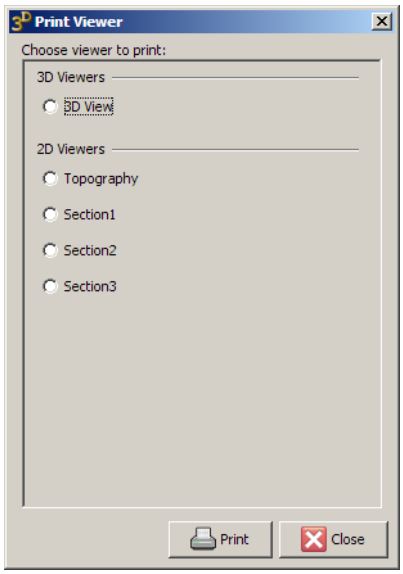
Print Viewer dialog box

Parent topic: Project menu, Project toolbar and dialog boxes

Use this dialog box to select which data display window you want to print.



Controls in this dialog box

Control	Purpose
3D Viewer	Print the current view in the **3D Viewer**
2D Viewers	Print the Topography or one of the Sections as you select.
Print	Display the **Print** dialog box
Close	Close the dialog box without printing

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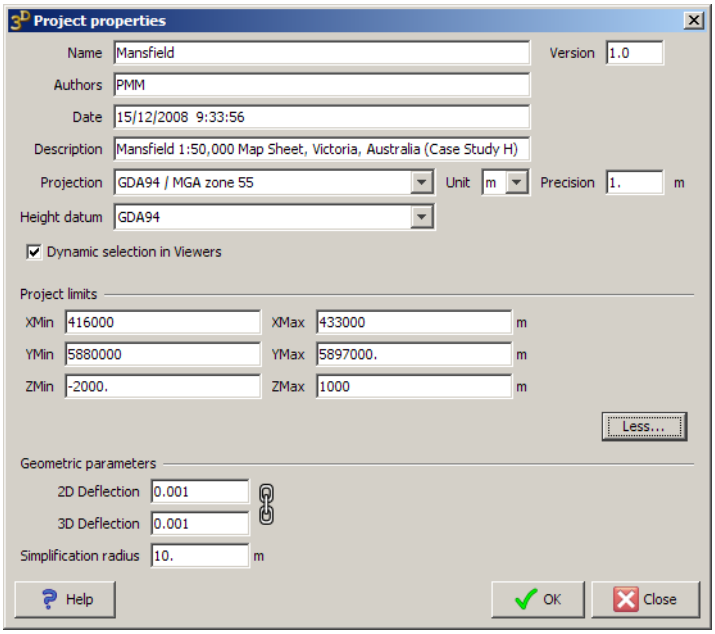
Project Properties dialog box

Parent topic: Project menu, Project toolbar and dialog boxes

Use this dialog box to create a new 3D GeoModeller project or edit the properties of an existing one.

Once you have created a project, you are not able to edit the Project extents or the Datum / Projection. You can hwoever edit data in the other fields at any time.



Controls in this dialog box

Control	Purpose
Name	Name of the 3D GeoModeller project.
Version	Version number of the project.
Authors	Names of the project's authors.
Date	Date and time of creation of the project.
Description	Brief description of the project.
Projection	Coordinate system (datum and projection) of the project. You can define only a rectilinear coordinate framework such as a projected coordinate system, in m, km or feet. You cannot use geodetic coordinates (latitude and longitude).
Height datum	The height (elevation) datum of the project.
Unit	The unit of measurement of the coordinates and elevation data of the project.
Precision	Precision to which 3D GeoModeller computes the model

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Control	Purpose
Dynamic selection in Viewers	Enable (checked) or disable (clear) dynamic selection. See Precision in representing curves and surfaces
Project limits: XMin, XMax	Minimum and maximum extents of the project in the X or East direction.
Project limits: YMin, YMax	Minimum and maximum extents of the project in the Y or North direction.
Project limits: ZMin, ZMax	Minimum and maximum extents of the project in the Z or Up direction. Specify all vertical measurements in 3D GeoModeller in terms of elevation, positive upwards, measured relative to the specified **Height Datum**.
More or **Less**	Show more or fewer parameters
Geometric parameters	
2D Deflection	See Precision in representing curves and surfaces.
3D Deflection	
Discretisation	

Notes

- Units are the same for all three coordinate directions, X, Y and Z.
- Once the topographic surface has been defined, you will not be able to modify the coordinates of the project's bounding box.
- Changing the precision and the geometrical parameters is not retroactive: it will affect only the objects created later.

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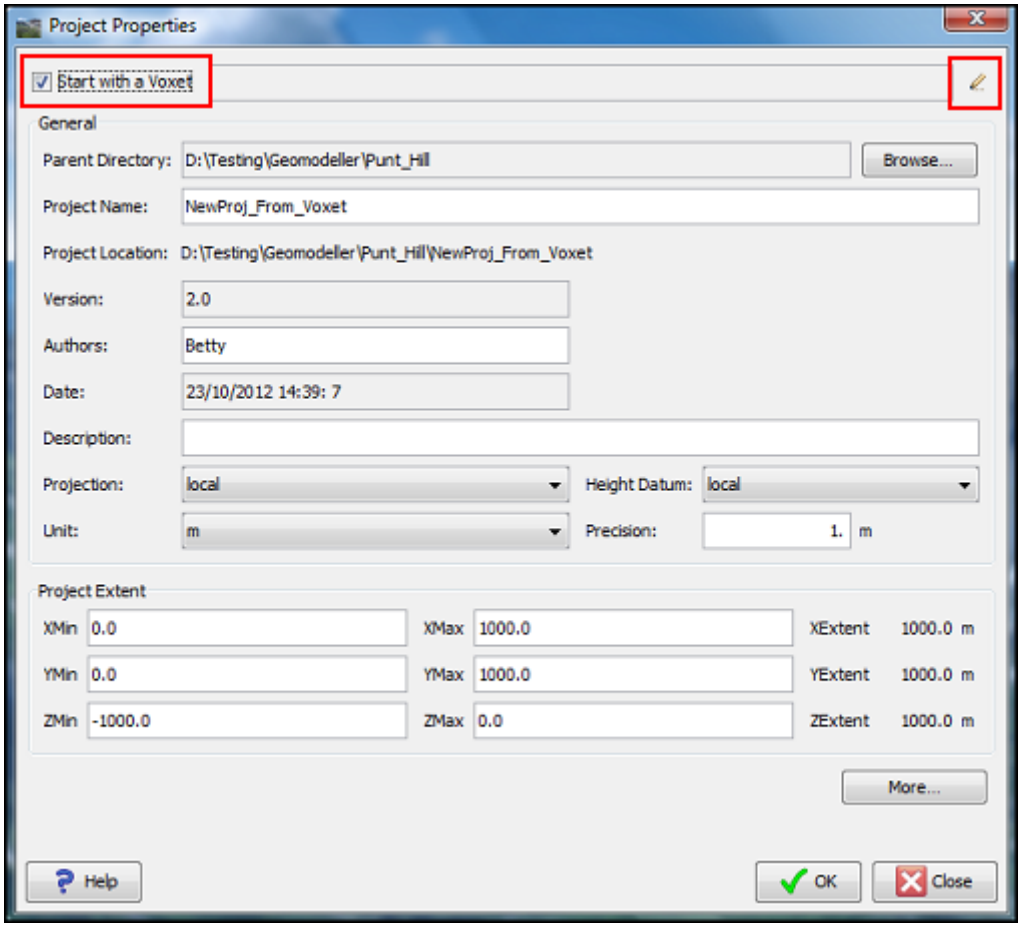
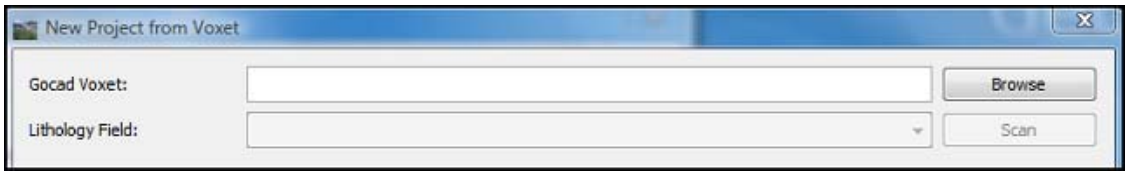
Create New Project from Voxet

To create a new project from a GoCAD voxet:

- Click on **Start with a Voxet** in the **Project->New** menu and then click on the red ringed pencil on the far right to choose the voxet to load.



- The dialog below will open; Browse and choose the lithology voxet to load.



- Once the voxet is selected, choose the Lithology field in the voxet and click on the **Scan** button. The **Scanned Lithologies** list will display the contents of the Lithology voxet as shown in the dialog below. If the GoCAD voxet contains the formation names or regions and colours in the header file then the original assigned formation names and colours will be populated in the **Scanned Lithologies** list. If not then the user has the ability to edit the Formation names, colours and index order as described below.

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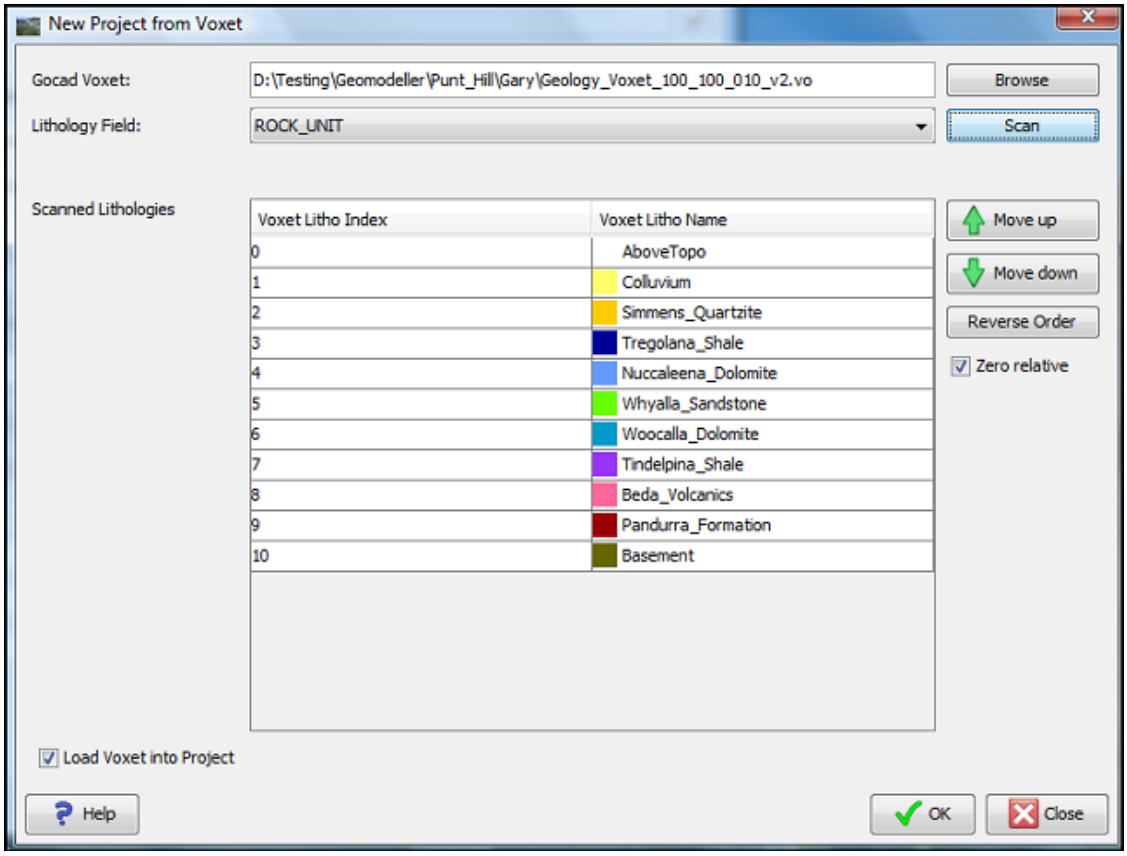

- The user can manipulate the Voxet litho indices shown in the scanned lithologies list as follows:
  - Click the **Reverse Order** button to reverse the index order so that the Formations are in the correct chronological order ie stratigraphic pile Youngest to Oldest (top to bottom in the list).
  - Select an Index and use the **Move up** or **Move down** buttons to obtain the correct stratigraphic order.
  - Double Left Click a voxet Litho Name or Voxet Litho Index to edit the existing colour and/or Lithology Name (see dialog figure below).
  - Unselect **Zero relative** when the geology indices are not zero relative ie start at 1 not 0 when is no zero index in the voxet (or vice versa).
  - The user can also choose whether to load the GoCAD voxet into the Mesh Grid tree inside the project. See the **Load voxet into Project** toggle switch at the bottom left. This might be turned off to conserve memory and can then be imported and displayed on demand or interactively loaded for geophysical forward modelling and inversion.

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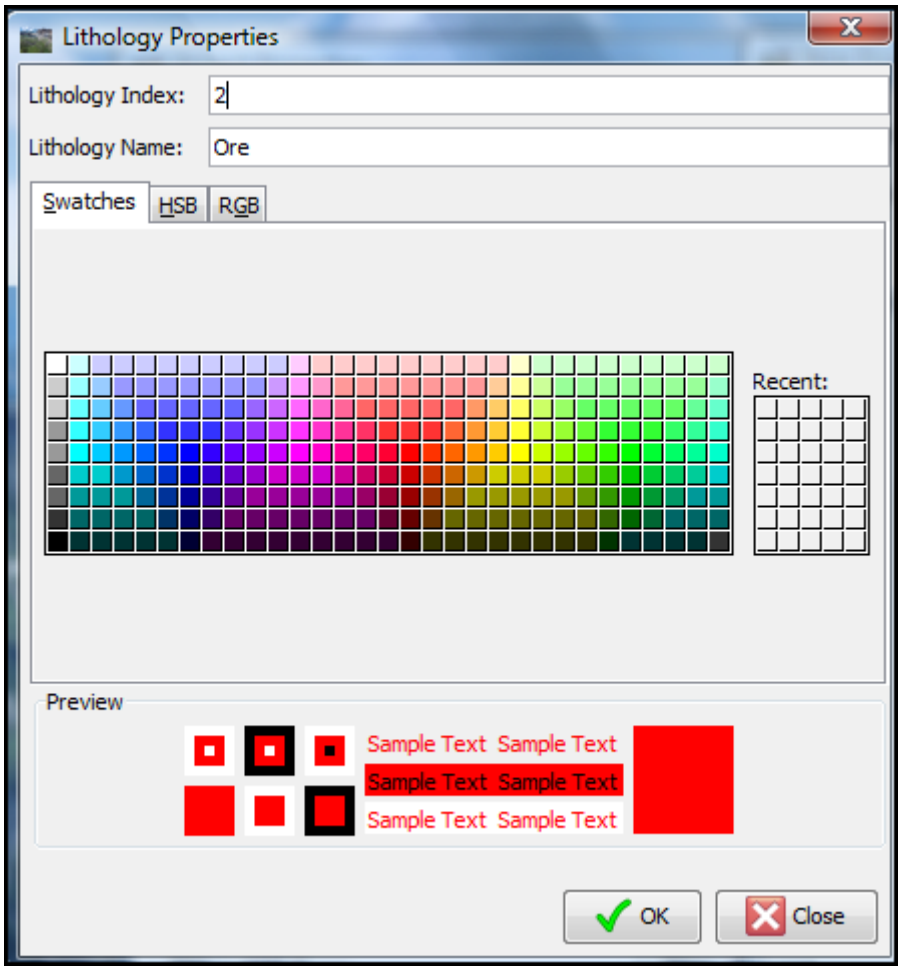

- Dialog for editing the existing colour and/or Lithology Name.

- When all the voxet formation options are set as required click **OK** to proceed
  - The project extents are automatically set to the loaded voxet extents as shown below. At this point the user proceeds to complete the new project dialog by choosing:
  - Project Name
  - Authors
  - Description
  - Projection (Datum / Projection pair)
  - Height Datum
  - Measurement Units (m, km, ft)
  - The spatial precision of the model in metres

Note: The **Project Name** is used to create a project directory containing the project xml file et al within the defined **Parent Directory**

ie Parent Directory\Project Name\Project Name.xml.

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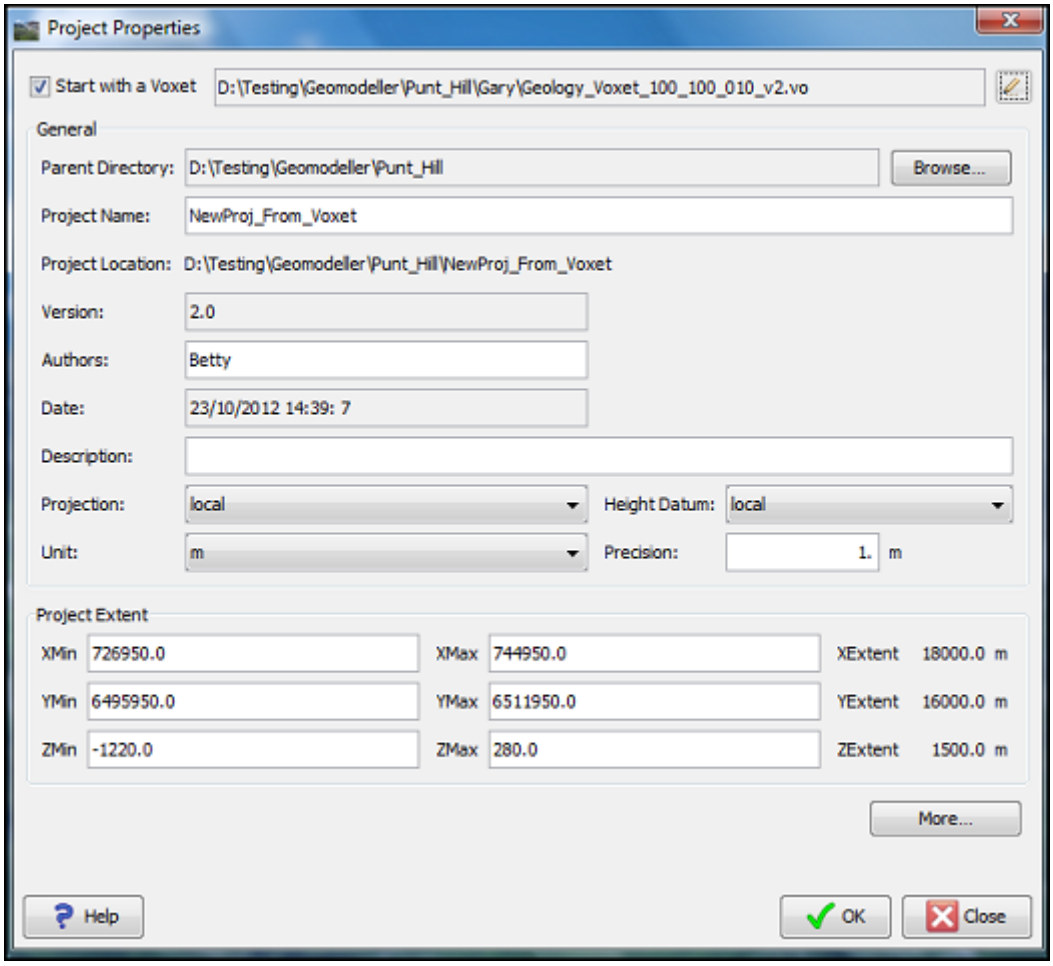

- When the Project dialog is completed click **OK** to proceed

  At this point the project is created using the voxet extents and the geological pile is built using the scanned lithologies list. The user may want to alter the default Erode/Onlap relationships in the stratigraphic pile to record the true relationships between them but these are not used directly during geophysical modelling (only the pile order can be honored).

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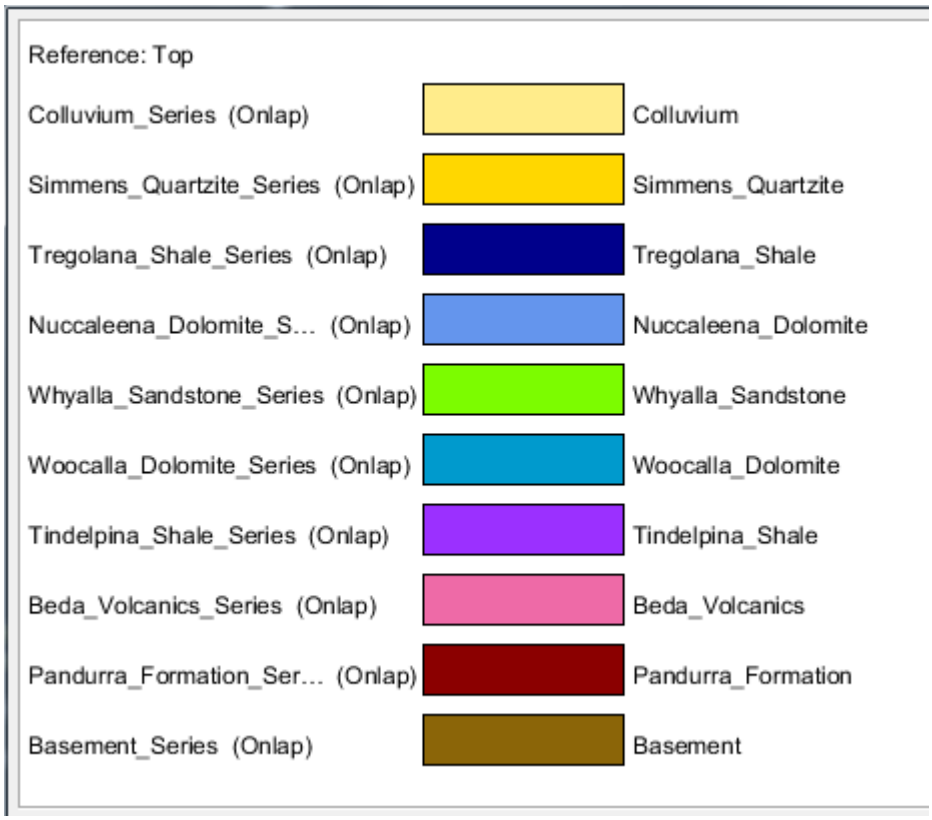

The user is not asked for a DTM as the DTM surface is normally embedded in the voxet ie the top of the first formation in the pile. The section of the voxet above the top of the first formation can be assigned to Above Topo if it has an index defined. Some times the Above Topo part of the voxet may be set to a Null value in the incoming GoCAD voxet. In this case the user may need to use the voxet editor to set the null value to zero for the purposes of geophysical forward modelling and inversion since the user may want to assign properties to this part of the model ie when calculating a Bouguer correction.

At this point the user can run geophysical forward or inverse modelling using the voxet as input. The user has two options for setting the geophysical properties for the lithology units.

- Use the Geophysical properties editor to set the properties of each formation as for a normal GeoModeller project OR
- Load a physical properties voxet derived from another source using the Load From Voxet option provided during geophysical forward modelling and inversion.

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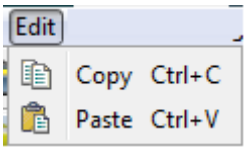
Edit menu and dialog boxes



- These menu items are used for the purpose of copying and pasting graphic items or selected GeoModeller objects to and from the Clipboard.

GeoModeller has other copy and paste menu items under objects in the Explore Tree for copying and pasting items from one GeoModeller project to another. They are useful for transferring basic geological items from an existing project when it is found necessary to change the project extents ie enlarge or reduce the coverage of a project

The supported items are:

- Copy/Paste Formations
- Copy/Paste Stratigraphic Pile
- Copy/Paste Dykes
- Copy/Paste Faults
- Copy/Paste Sections (The DTM is not copied with the Surface Topography Section)

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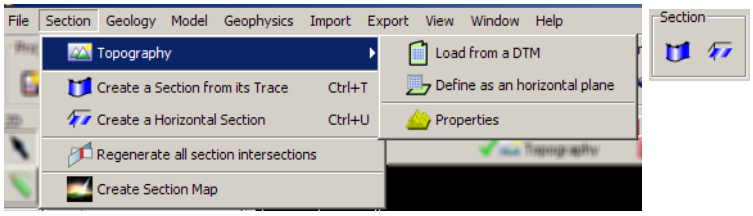
Section menu, toolbar and dialog boxes

Parent topic: 3D GeoModeller main menus

Use the **Section** menu to manage the topography and sections in your model.



See the following table for an overview of the **Section** menu

Option	Description	Tool	Keys
Topography > Load from a DTM	See Load Topography from a DTM dialog box		CTRL+T
Topography > Define as a horizontal plane	See Define Topography as an Horizontal Plane dialog box		CTRL+U
Topography > Properties	See Topography Properties dialog box		
Create a Sector from its Trace	See Create a Section from its Trace dialog box		
Create a Horizontal Sector	See Create a Horizontal Section dialog box		
Regenerate all section intersection	Occasionally after you have added new data, 3D GeoModeller may not fully update the relationships between sections. If the relationships do not appear correctly, choose this option to regenerate them.		
Create a section map	See Section Map dialog box		

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Load Topography from a DTM dialog box

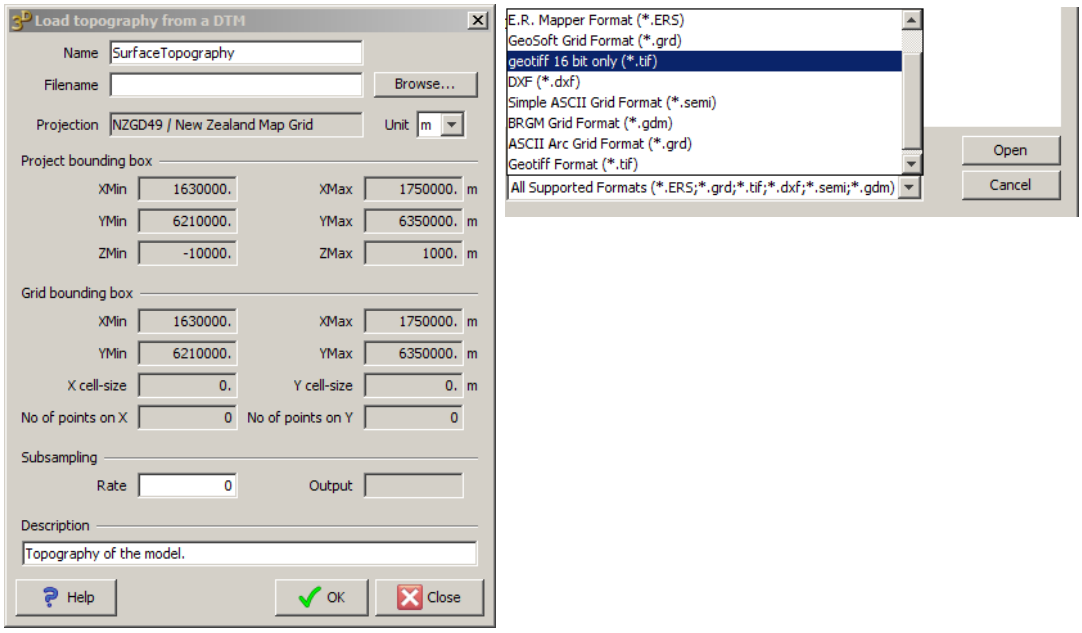
Parent topic: Section menu, toolbar and dialog boxes

Use this dialog box to import the Digital Terrain Model (DTM) for the Project, and create the Project's **SurfaceTopography** Section.

The SurfaceTopography Section in 3D GeoModeller is the section on which you either import or digitise all surface geological mapping data. The plot of the modelled geology on the **SurfaceTopography** section is essentially the 'geological map' for the project.

If you have a digital terrain model (DTM), you can import it to 3D GeoModeller.

For details about DTM import, see How 3D GeoModeller imports the DTM.



Supported DTM file formats

- ERMapper and INTREPID grid datasets (**.ers**)
- Geosoft grids (**.grd**)
- GeoTIFF 16 bit grids (**.tif**)
- Simple ASCII grid format (**.semi**)
- BRGM grid format (**.gdm**)
- ASCII Arc grid format (**.grd**)

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Controls in this dialog box

Control	Purpose
Name	Name of the surface topography section. The default is **`SurfaceTopography`**, but you can use any name. You cannot use spaces in section names.
Filename	Name of the DTM grid file. Choose **Browse** to browse for the file. **Notes** • 3D GeoModeller clips a DTM dataset if it is larger in X or in Y than the bounding box of the project. • The vertical range of the DTM topography values must lie within the specified Z limits of the project.
Projection	Projection of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Units	Distance unit of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Project bounding box	**XMin**, **XMax**, **YMin**, **YMax**, **ZMin** and **ZMax** parameters are the Project extents of the 3D GeoModeller Project in the X (east), Y (north) and Z (up) directions respectively. 3D GeoModeller dispays this for your information. You cannot edit it here.
Grid bounding box	**XMin**, **XMax**, **YMin** and **YMax** parameters are the extents of the chosen grid file in the X (East) and Y (North) directions respectively. The data are the cell centroid values of the grid extremities. 3D GeoModeller dispays this for your information. You cannot edit it here.
X cell size, Y cell size	Cell size of the grid cells in the X (east) and Y (north) directions respectively. 3D GeoModeller dispays this for your information. You cannot edit it here.
Nb of points on X, Y	Number of grid cells in the X (east) and Y (north) directions respectively according to the subsampling rate that you specified. 3D GeoModeller dispays this for your information. You cannot edit it here.

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Control	Purpose
Subsampling: Rate	By default, 3D GeoModeller subsamples a DTM grid to a resolution of approximately 100 x 100 grid cells in the East and North directions. **Rate** specifies the subsampling interval in terms of 'number of grid cells'. 3D GeoModeller uses only every nth grid cell (where n is the specified **Rate**) to create the surface topography section. **Note:** During import, by default, 3D GeoModeller subsamples an imported DTM to a resolution of 100 x 100 cells. It does this for performance reasons but this action can seriously degrade DTM quality. You can override this by adjusting (decreasing) the parameter. We recommend that you do not exceed a resolution of 250 x 250 cells.
Subsampling: Output	Total number of grid cells—after subsampling—that 3D GeoModeller uses to generate the surface topography section.
Description	Your note about the source of the DTM data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.

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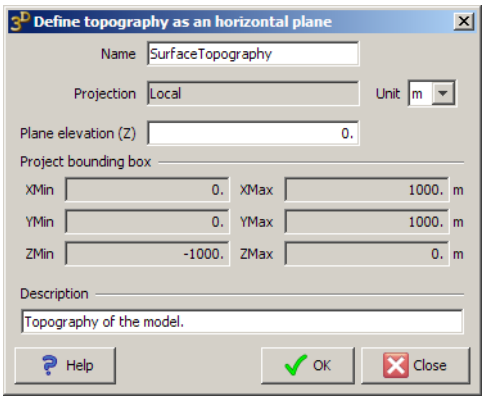
Define Topography as an Horizontal Plane dialog box

Parent topic: Section menu, toolbar and dialog boxes

If you don't currently have topographic data, you can simply define the topography as a horizontal plane.



Controls in this dialog box

Control	Purpose
Name	Name of the surface topography section. The default is **`SurfaceTopography`**, but you can use any name. You cannot use spaces in section names.
Projection	Projection of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Units	Distance unit of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Plane elevation (Z)	Z level (altitude or RL) of the plane that forms your project 'topography'
Project bounding box	**XMin**, **XMax**, **YMin**, **YMax**, **ZMin** and **ZMax** parameters are the Project extents of the 3D GeoModeller Project in the X (east), Y (north) and Z (up) directions respectively. 3D GeoModeller dispays this for your information. You cannot edit it here.
Description	Your note about the surface topography section. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
OK	Create and post the topographic surface in the **3D Viewer.** Open a **2D Viewer** window containing the 'map' view.

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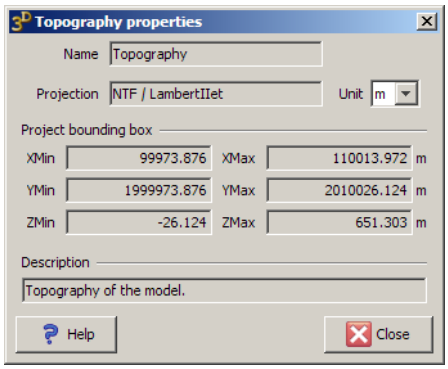
Topography Properties dialog box

Parent topic: Section menu, toolbar and dialog boxes

This dialog box shows the properties of the topography of your model.



Controls in this dialog box

Control	Purpose
Name	Name of the surface topography section. 3D GeoModeller dispays this for your information. You cannot edit it here.
Projection	Projection of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Unit	Distance unit of the project coordinate system. 3D GeoModeller dispays this for your information. You cannot edit it here.
Project bounding box	**XMin**, **XMax**, **YMin**, **YMax**, **ZMin** and **ZMax** parameters are the Project extents of the 3D GeoModeller Project in the X (east), Y (north) and Z (up) directions respectively. 3D GeoModeller dispays this for your information. You cannot edit it here.
Description	Your note about the surface topography section. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.

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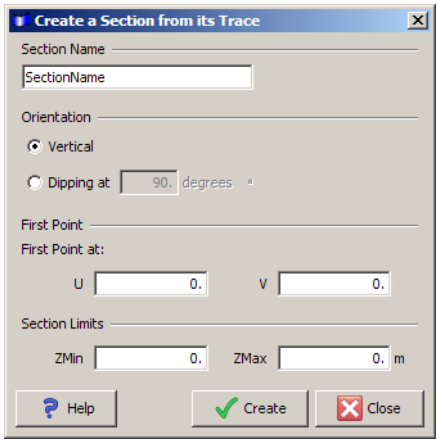
Create a Section from its Trace dialog box

Parent topic: Section menu, toolbar and dialog boxes

If you have a set of points in the points list, you can use them to create a section. Use this dialog box to specify the section to be created.



Controls in this dialog box

Control	Purpose
Section name	Name of section
Orientation	Dip of the line of greatest slope (from –90° to +90°). A vertical section has a dip of –90°.
First point	(If required) The origin of the section, using specific (u, v) coordinates of the first point of the trace in the section
Section limits	**ZMin** and **ZMax** parameters are the vertical extents of the defined section. They must be within the project extents of the 3D GeoModeller Project

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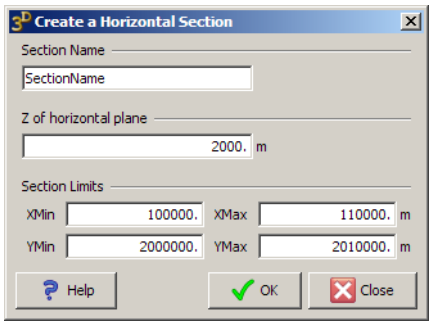
Create a Horizontal Section dialog box

Parent topic: Section menu, toolbar and dialog boxes

Use this dialog box to specify a horizontal section in the model.



Controls in this dialog box

Control	Purpose
Section name	Name of the new section
Z of horizontal plane	Z value (or RL) for the section. It must be between the **ZMin** and **ZMax** of the project. See Project Properties dialog box
Section limits	**XMin**, **XMax**, **YMin** and **YMax** are the extents of the defined horizontal section in the X (east) and Y (north) directions. They must be within the project extents of the 3D GeoModeller Project.

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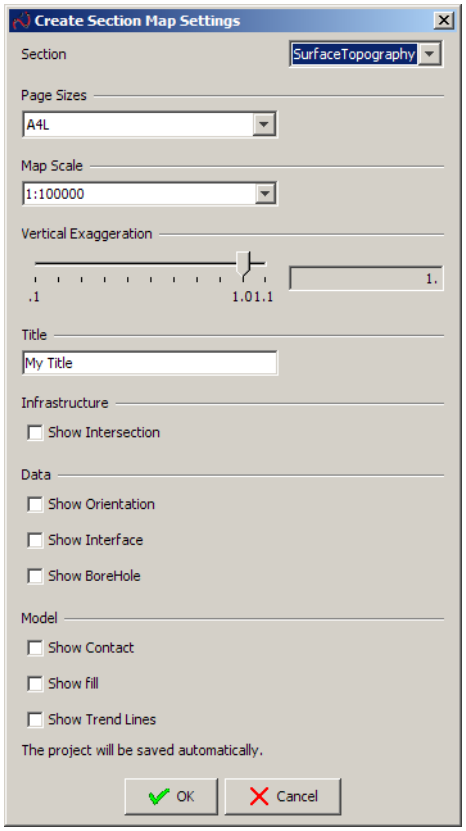
Section Map dialog box

Parent topic: Section menu, toolbar and dialog boxes

Use this dialog box to specify and create a map image of the currently selected section.



You can save the map image in the following formats:

- **.png**
- **.gif**
- **.eps** (Encapsulated Postscript)

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Controls in this dialog box

Control	Purpose
Section	Section used to make the section map
Page sizes	Printed page size of the section map
Map Scale	Scale of the section map
Vertical Exaggeration	Degree of vertical exaggeration
Title	Title of the section map
Infrastructure	
Show Intersection	When checked, the intersections of formations appear on the section map
Data	
Show Orientation	When checked, orientation data appears on the section map
Show Interface	When checked, interfaces between formations appear on the section map
Show drillhole	When checked, drillholes appear on the section map
Model	
Show Contact	When checked, the contact lines between the formations appear on the section map
Show Fill	When checked, all infilling applied to the formations appears on the section map
Show Trend Lines	When checked, the trend lines for the series within the formations appear on the section map

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Geology menu and dialog boxes

Parent topic: 3D GeoModeller main menus

- Geology menu, cascades and the Structural toolbar
- Formations
  - Create or Edit Geology Formations dialog box
  - Edit Geological Formation Attributes dialog box
- Geology series and the stratigraphic pile
  - Create or Edit Geology Series and the Stratigraphic Pile dialog box
  - Create or Edit Geology Series dialog box
  - External Constraints dialog box
  - Stratigraphic pile viewer
- Geology data
  - Create (or Edit) Geology Data dialog box
  - Create (or Edit) Geology Orientation Data dialog box
  - Fit a Plane to Points Create Orientation Data dialog box
- Faults
  - Create or Edit Faults dialog box
  - Fault Properties (attributes) dialog box
  - Links Faults with Series dialog box
  - Link Faults with Faults dialog box
- Axial data
  - Create or Edit Axial Series dialog box
  - Create or Edit Axial Surfaces dialog box
  - Axial Surface Attributes dialog box
  - Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box
  - Create (or Edit) Axial Surface Orientation Data dialog box
  - Create a Section from an Axial Surface dialog box
  - Create (or Edit) Hinge Line Data dialog box
- Provenance
  - Provenance Editor dialog box

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Geology menu, cascades and the Structural toolbar

Parent topic: Geology menu and dialog boxes

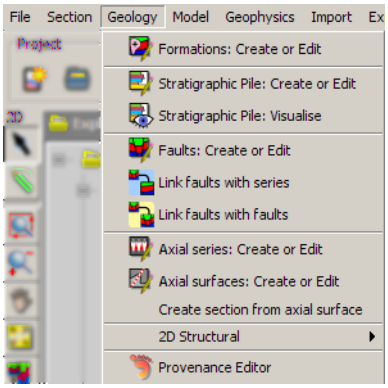
The Geology menu has a cascade menu, 2D Structural. In this section:

- Geology menu
- 2D Structural sub menu and Structural toolbar

Geology menu

Parent topic: Geology menu, cascades and the Structural toolbar

Use **Geology** menu options to create and edit geological objects in your geological model, such as formations, the stratigraphic pile, faults and axial series and surfaces.



See the following table for an overview of the **Geology** menu

Control	Purpose
Create or edit formations	See Create or Edit Geology Formations dialog box
Create or edit stratigraphic pile	See Create or Edit Geology Series dialog box
Visualise stratigraphic pile	See Stratigraphic pile viewer
Create or edit faults	See Create or Edit Faults dialog box
Link faults with series	See Links Faults with Series dialog box
Link faults with faults	See Link Faults with Faults dialog box
Create or edit axial series	See Create or Edit Axial Series dialog box
Create or edit axial surfaces	See Create or Edit Axial Surfaces dialog box
Create section from axial surface	See Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box
2D structural	See 2D Structural sub menu and Structural toolbar.
Provenance editor	See Provenance Editor dialog box

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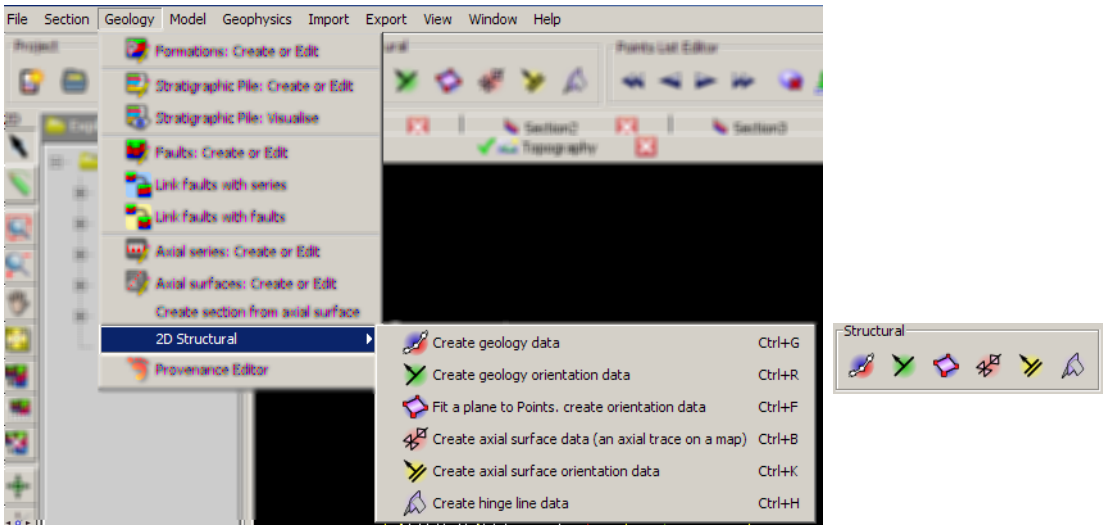
Parent topic: Geology menu, cascades and the Structural toolbar

2D Structural sub menu and Structural toolbar

Use the **Structural** toolbar and cascade menu to add data to geological objects in the model.



See the following table for an overview of the **2D Structural** sub menu and **Structural** toolbar

Control	Purpose	Tools	Keys
Create geology data	See Create or Edit Geology Formations dialog box		CTRL+G
Create geology orientation data	See Create (or Edit) Geology Orientation Data dialog box		CTRL+R
Fit a plane to points	See Fit a Plane to Points Create Orientation Data dialog box		CTRL+F
Create axial surface data	See Create or Edit Axial Surfaces dialog box		CTRL+B
Create axial surface orientation data	See Create (or Edit) Axial Surface Orientation Data dialog box		CTRL+K
Create hinge line data	See Create (or Edit) Hinge Line Data dialog box		CTRL+H

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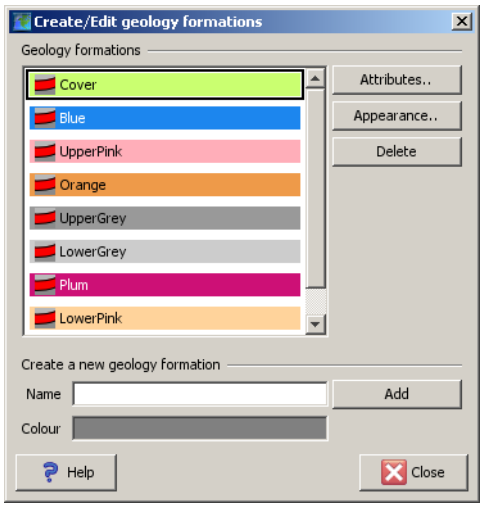
Create or Edit Geology Formations dialog box

Parent topic: Geology menu and dialog boxes

With the **Create or Edit geology formations** dialog box you can create, edit or delete geology formations.

Tip If you are editing a formation, before opening this dialog box, select the formation that you want to edit.



Operations that use this dialog box

- Creating geology formations
- Editing geology formations
- Deleting geology formations

Controls in this dialog box

Control	Purpose
Geology formations	Formations in the project. Select (click) a formation for editing or deleting.
Attributes	Edit the attributes of the selected formation. Displays the Project Properties dialog box
Appearance	Edit the attributes of the selected formation. Displays the Appearance of objects dialog box family
Delete	Delete the selected formation
Create a new geology formation	
Name	Name of a new formation
Colour	Click in this field to select colour for the new formation. Uses the Colour Palette dialog box.
Add	Add the new formation (Choose this after you have named it and selected a colour.)

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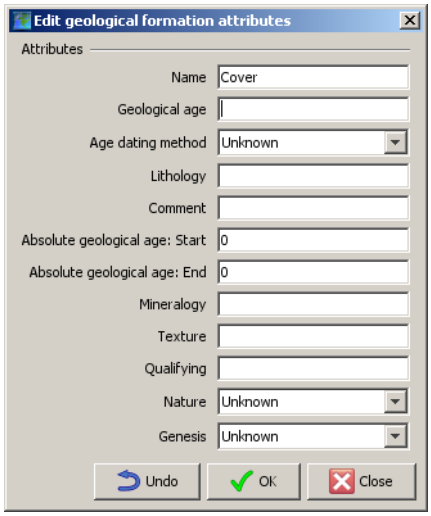
Edit Geological Formation Attributes dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to record information about a formation.

3D GeoModeller only uses the data in the **Name** field. All other data is simply recorded information (metadata) about the formation



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Controls in this dialog box

Control	Purpose
Name	Name of the formation
Geological age	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Age dating method	Select from Unknown, Palynology or Gas Chronology 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Lithology	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Comment	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Absolute geological age: Start	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Absolute geological age: End	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Minerology	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Texture	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Qualifying	3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Nature	Select from Unknown, Magmatic, Sedimentary, Metamorphic, Meteological alteration, or Anthropic deposit. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Genesis	3D GeoModeller provides this space for your notes. It does not use the data in calculations.

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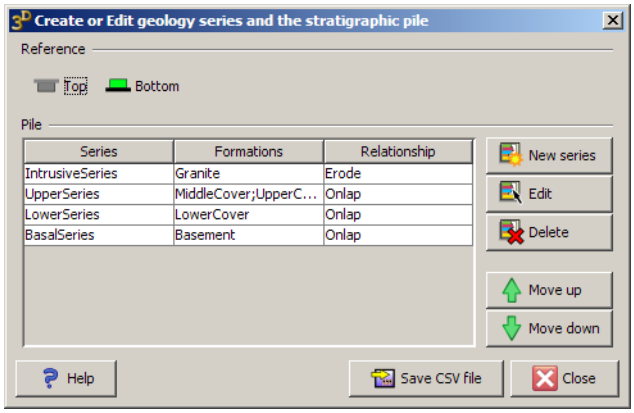
Create or Edit Geology Series and the Stratigraphic Pile dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to organise the sequence of series in the stratigraphic pile, and for access to the controls for creating and editing geological series.



Controls in this dialog box

Control	Purpose
Reference	Reference of the stratigraphic pile —**Top** or **Bottom**. Determines whether the geology observations represent the top or the bottom of defined geological formations.
New Series	Create new geology series. Displays **New Geology Series** dialog box. See Create or Edit Geology Series dialog box
Edit	Edit the selected geology series. Displays Create or Edit Geology Series dialog box
Delete	Delete the selected series
Move up	Reposition the selected series up the stratigraphic order
Move down	Reposition the selected series down the stratigraphic order
Save CSV file	Save the stratigraphic sequence as a **`.csv`** (comma separated variable) text file

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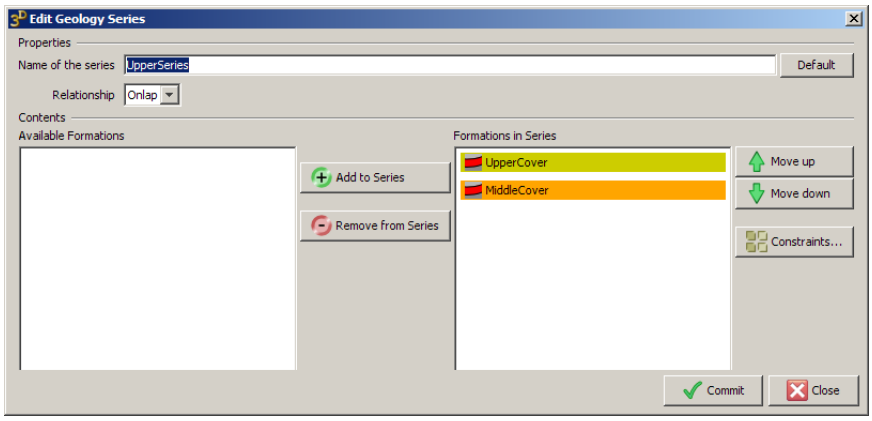
Create or Edit Geology Series dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to create and edit a geological series. Before creating a series starting you need to have already created the formations that belong to the series. See Geology formations and series operations.



Controls in this dialog box

Control	Purpose
Name of the series	Name of the series
Default	Revert to the default name for the series. The default the series name is the name of its highest formation with `_Series` appended
Relationship	Type of relationship for this series (Erode or Onlap). The default value is Onlap
Available Formations	Available geology formations to add to the series
Add to Series	Add the formations selected in the **Available Formations** list to the **Formations in Series** list
Remove from Series	Remove the formations selected in the **Formations in Series** list. After you choose this button they appear in the **Available Formations** list.
Formations in Series	Formations included in the series being created or edited.
Move up, Move down	Set stratigraphic order of geology formations in the series
Constraints	Select formations outside this series that partly conform to it and use contact or orientation data from them in modelling it. See External Constraints dialog box
Commit	Save the changes you have made

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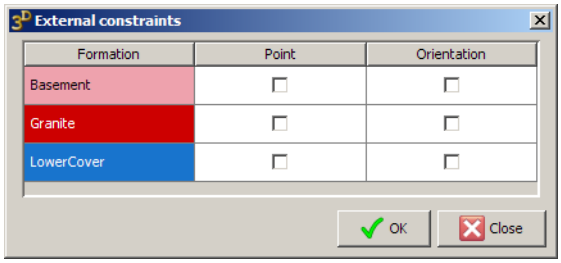
External Constraints dialog box

Parent topic: Geology menu and dialog boxes

You can use data from other formations to help compute the model of this formation. Use this dialog box to select the formations and the data that you want to use.

Note that, in the current version of 3D GeoModeller you have to use all of the selected data from the other formation. You can't only select the points that you consider relevant.



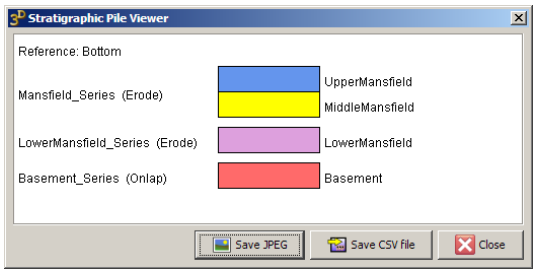
Controls in this dialog box

Control	Purpose
Formation	Name of the external formation whose data you may reference
Point	When checked, 3D GeoModeller uses contact data belonging to that formation in calculating the model for the current formation.
Orientation	When checked, 3D GeoModeller uses orientation data belonging to that formation in calculating the model for the current formation.

Stratigraphic pile viewer

Parent topic: Geology menu and dialog boxes

The **Stratigraphic Pile Viewer** shows you the series in your project, in order, and the formations they contain.



Controls in this dialog box

Control	Purpose
Save JPEG	Save an image of the diagram as a `.jpg` file
Save CSV file	Save a description of the stratigraphic pile as a `.csv` (comma separated variables) text file

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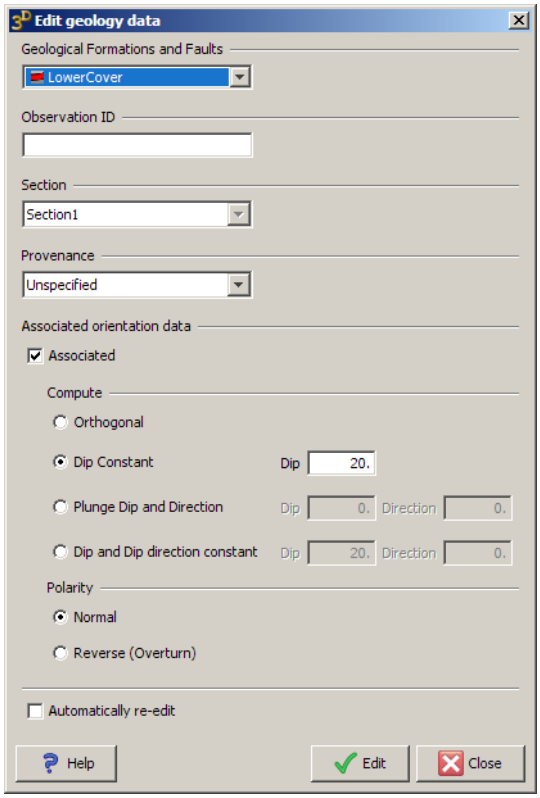
Create (or Edit) Geology Data dialog box

Parent topic: Geology menu and dialog boxes

Use the **Create or Edit Geology Data** dialog box to:

- Create a set of geology contact points from the points in the **Points List**
- Set the properties of a set of geology contact points



When you create a set of geology contact points, 3D GeoModeller takes them from the **Points List**. Before

When you edit a set of geology contact points, 3D GeoModeller loads them into the **Points List**. When you choose **Edit**, 3D GeoModeller replaces the set of points with the ones from the **Points List**. Before you choose **Edit**, you can edit the points using the **Points List Editor**. See Editing geological data with the Points List for more information.

If you are working on a number of different sets of geology contact data, you can leave this dialog box open in your 3D GeoModeller workspace.

Controls in this dialog box

Control	Purpose
Geological formations and faults	Formation or fault on which the point is located
Observation ID	Your label for the data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	Section containing the geology data points

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Control	Purpose
Provenance	Source of the geology data. See Provenance Editor dialog box to see the default settings or to create or edit new categories.
Associated orientation data	If you don't have specific orientation points available, you can associate geology orientation data with the geology data points. For information about orientation data symbols and conventions see Orientation data plot symbols.
Compute	Methods of computing the associated orientation data
Orthogonal	Associated orientation data points are perpendicular to the section plane
Dip constant	Associated orientation data points have a constant dip that you specify. Dip direction is perpendicular to the formation contact that the points are defining.
Plunge dip and direction	Associated orientation data points have a constant plunge and plunge direction that you specify.
Dip and dip direction constant	Associated orientation data points have a constant dip and dip direction that you specify.
Polarity	If the geology at the contact points is overturned, select **Reverse**. If the geology is not overturned, select **Normal**. See Overturned geology.
Automatically re-edit	When checked, 3D GeoModeller does not empty the **Points List** when you choose **Edit** or **Create**. This enables you to continue editing the data. See Editing geological data with the Points List for more information.

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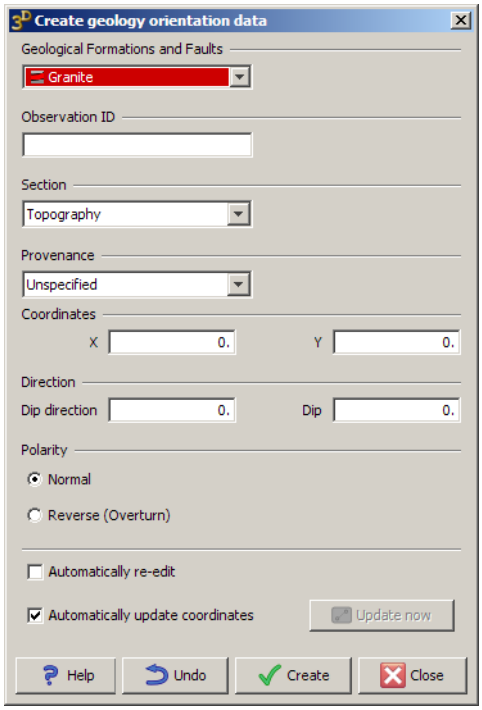
Create (or Edit) Geology Orientation Data dialog box

Parent topic: Geology menu and dialog boxes

Input the coordinates, dip direction, dip and the polarity of your geology orientation data



Controls in this dialog box

Control	Purpose
Geological formations and faults	Geology formation or fault associated with the geology orientation data
Observation ID	Your own reference number for this data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	Section containing the geology data points
Provenance	Source of the geology data. See Provenance Editor dialog box for the default settings or to create or edit new categories.
Coordinates: X, Y	u, v coordinates of the orientation point in the section. This point is at the intersection of the baseline and pointer of the symbol. You can enter coordinates automatically from the **Points List**. See 'Automatically update coordinates' below in this table.

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Control	Purpose
Direction	**Dip** and **Dip direction** of the orientation point. See Orientation data plot symbols for further information You can enter **Dip direction** automatically from the **Points List**. See 'Automatically update coordinates' below in this table.
Polarity	If the geology at the orientation point is overturned, select **Reverse** If the geology is not overturned, select **Normal**. See Overturned geology.
Automatically re-edit	When checked, 3D GeoModeller does not empty the **Points List** when you choose **Edit** or **Create**. This enables you to continue editing the data. See Editing geological data with the Points List for more information.
Automatically update coordinates **Update now**	When checked, 3D GeoModeller automatically: • Updates **X** and **Y** with the coordinates of the most recent point in the **Points List** • Updates **Dip direction** with a direction that it calculates using the most recent two points in the **Points List** When not checked: • 3D GeoModeller does not automatically update **X**, **Y** and **Dip direction** from the **Points List**. • When you choose **Update now**, 3D GeoModeller updates **X**, **Y** and **Dip direction** from the **Points List**. as described above.

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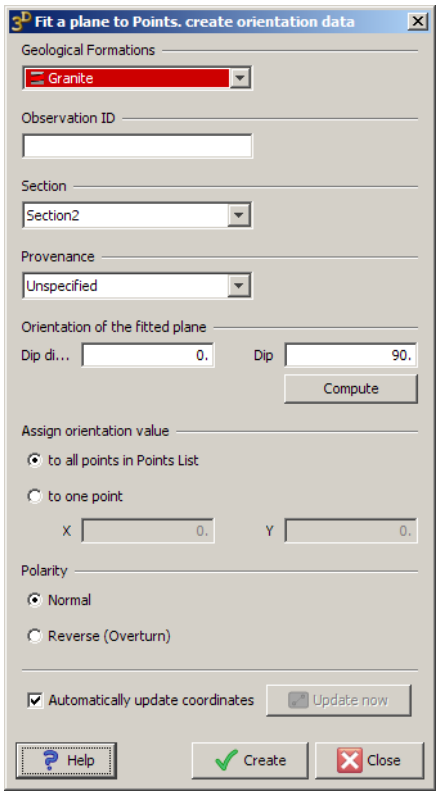
Fit a Plane to Points Create Orientation Data dialog box

Parent topic: Geology menu and dialog boxes

If you are certain that a formation contact is planar and know four contact points, then 3D GeoModeller can calculate orientation data. Enter the points into the Points List and use the **Fit a Plane to Points Create Orientation Data** dialog box.



This enables you to obtain the dip direction and the dip of the best fit plane fitted to several data points. This is useful, for example, when you have outcrops of a formation, or the boundary limits (contacts) of this formation on the DTM, but do not have any orientation measurements. By recording these geology data points, and doing this calculation, 3D GeoModeller fits the average plane through the selected points.

You can capture the result (dip and dip direction) in the form of new geology orientation data at one or all of the points used.

Controls in this dialog box

Control	Purpose
Geological formations	The geological formation at the surface of which you want to fit the plane to the points data
Observation ID	Your label for the data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	Section containing the points that you are using
Provenance	Source of the geology data. See Provenance Editor dialog box to see the default settings or to create or edit new categories.

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Control	Purpose
Orientation of the fitted plane: Dip direction, Dip	Dip and dip direction of the fitted plane. When you choose **Compute**, 3D GeoModeller calculates this from the contact points you specify. You can also edit them directly. See Orientation data plot symbols for further information.
Compute	Choose **Compute** to calculate the dip and dip direction of the plane based on the points present in the **Points List**. **Note:** Before computing the plane orientation, you need to load the contents of the **Points List**. See 'Automatically update coordinates' below in this table.
Assign orientation value	You can create orientation data points: • From all the points present in the **Points List** • From one point with specified (X, Y) coordinates. The default point is the last entered point in the **Points List**. **Note:** Before creating the orientation points, you need to load the contents of the **Points List**. See 'Automatically update coordinates' below in this table.
Polarity	If the geology at the contact points is overturned, select **Reverse**. If the geology is not overturned, select **Normal**. See Overturned geology.
Automatically update coordinates **Update now**	When checked, 3D GeoModeller automatically loads the coordinates of the points in the **Points List**, ready to compute the plane and create the orientation points that describe it When not checked: • 3D GeoModeller does not automatically load the contents of the **Points List**. • When you choose **Update now**, 3D GeoModeller loads the contents of the **Points List** ready to compute the plane and create the orientation points that describe it.
Create or **Edit**	Apply the changes that you have specified. The title of the button depends on whether you are creating a new set of points or editing an existing set

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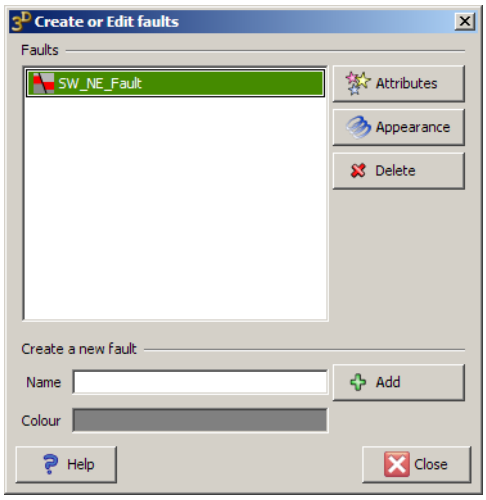
Create or Edit Faults dialog box

Parent topic: Geology menu and dialog boxes

These attributes enable a detailed (geological) description of the fault.



Controls in this dialog box

Control	Purpose
Faults	Faults in the project. Select (click) a fault for editing or deleting.
Attributes	Edit attributes of the selected fault. See Fault Properties (attributes) dialog box
Appearance	Edit appearance of the selected fault. See Appearance of objects dialog box family
Delete	Delete the selected fault
Create a new fault	
Name	Name for a new fault that you are creating
Colour	Click in this field to select colour for the new fault. Uses the Colour Palette dialog box.
Add	Add the new fault. Choose this after you have named it and selected the colour.

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Fault Properties (attributes) dialog box

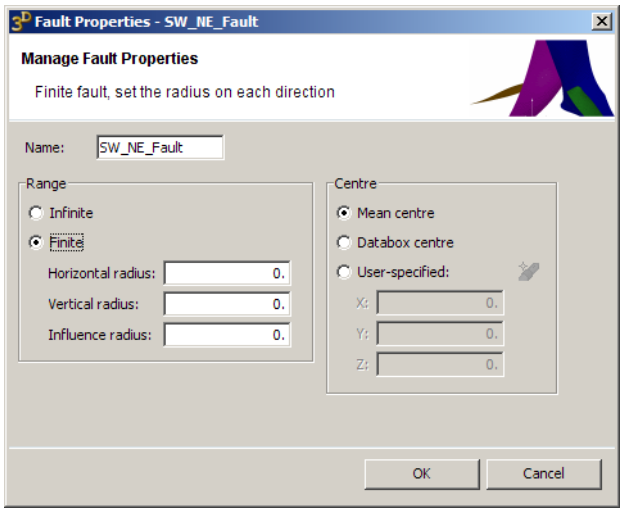
Parent topic: Geology menu and dialog boxes

When you define a fault, you can specify it as:

- Infinite, extending to the edges of the project space OR
- Finite, extending some distance from the known points.

When we specify a finite fault in 3D GeoModeller we define an ellipsoid within which we have decided that the fault exists.

We therefore need to define the centre and the three radii of this ellipsoid. We use axes oriented to the line of known contact points and to the plane of the section on which we have defined the known contact points.



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Controls in this dialog box

Control	Purpose
Name	Fault name
Range	Range of existence of the fault
Infinite or Finite	**Infinite**: Fault extends to the boundaries of the project space **Finite**: Exists within the ellipsoid that we define
Horizontal radius	Radius of the ellipsoid along the line of the known points in the section
Vertical radius	Radius of the ellipsoid in the direction perpendicular to the section
Influence radius	Radius of the ellipsoid in the plane of the section in the direction perpendicular to the line of known contact points
Centre	Methods of defining the centre of the ellipsoid
Mean centre	Coordinates of the ellipsoid centre are the means of the coordinates of the known contact points
Databox centre	Coordinates of the ellipsoid centre are the centre, in the section, of the rectangle containing all of the known contact points.
User-specified	Coordinates of the ellipsoid centre that you specify as X, Y, Z, within the project space

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Links Faults with Series dialog box

Parent topic: Geology menu and dialog boxes

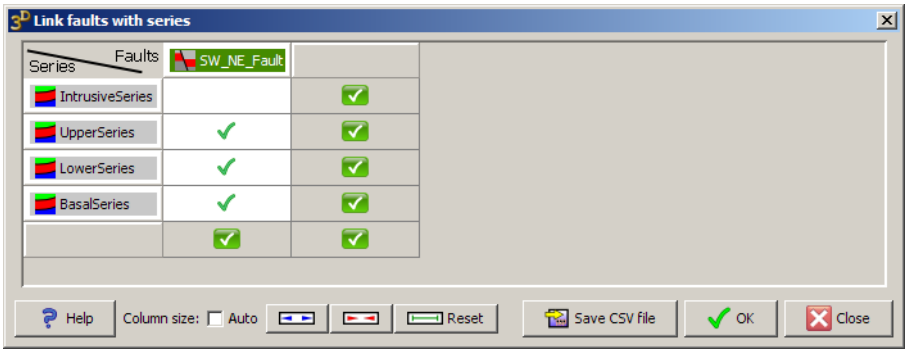
Use this dialog box to define the relationship of faults with the defined geology series. You can instruct 3D GeoModeller to ignore or take faults into account when interpolating the geology series in your project.

The geology series in your project are designated by rows and the defined faults are designated by columns.

To specify that a fault be taken into account in the interpolation of the chosen geology series check the cell at the intersection of a series and a fault. A fault passes through the geology series when the cell at the intersection of a series and the fault is checked.

To ignore the specified fault in the interpolation of the chosen geology series clear the cell at the intersection of a series and a fault.

Note You can check or clear all of a row or column at the same time by using the buttons at the ends of the rows or column.



Controls in this dialog box

Control	Purpose
Column width controls	See Column width controls
Save CSV file	Export the list of faults linked to series as a `.csv` (comma separated variable) text file

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Link Faults with Faults dialog box

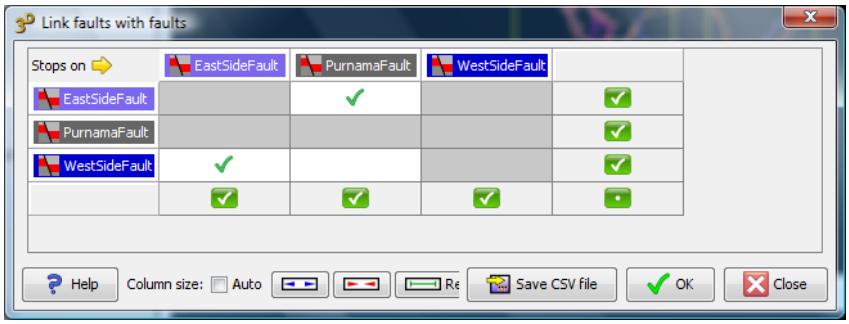
Parent topic: Geology menu and dialog boxes

Using this table you can define the termination of one fault on another.

To make fault B terminate on fault A check the cell at the intersection of the row B and column A.

Two faults cannot be interdependent: if fault B terminates on A, then fault A cannot terminate on B. For this reason, when a cell is checked, the corresponding symmetrical cell becomes inactive and is greyed-out.

Note: You can check or clear all of a row or column at the same time by using the buttons at the ends of the rows or column.



Controls in this dialog box

Control	Purpose
Column width controls	See Column width controls
Save CSV file	Export the list of faults linked to faults as a `.csv` (comma separated variable) text file

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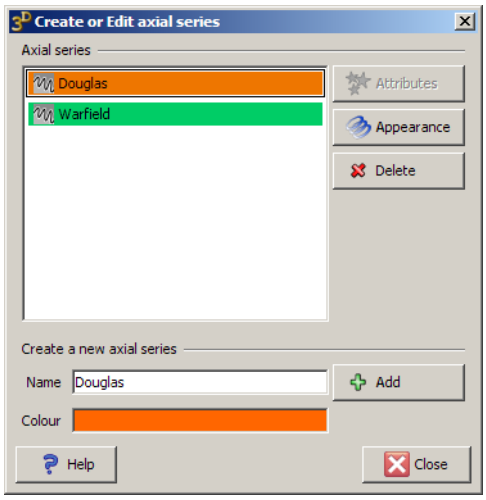
Create or Edit Axial Series dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to create or edit axial series (axial families).



Controls in this dialog box

Control	Purpose
Axial series	Axial series in the project. Select (click) a series for editing or deleting
Attributes	Not in use
Appearance	Edit the appearance of the selected axial series. See Appearance of objects dialog box family.
Delete	Delete the selected axial series.
Create a new axial series (family)	
Name	Name of a new axial series
Colour	Click in this field to select colour for the new axial series (family). Uses the Colour Palette dialog box.
Add	Add a new axial series. Choose this after you have named it and selected the colour

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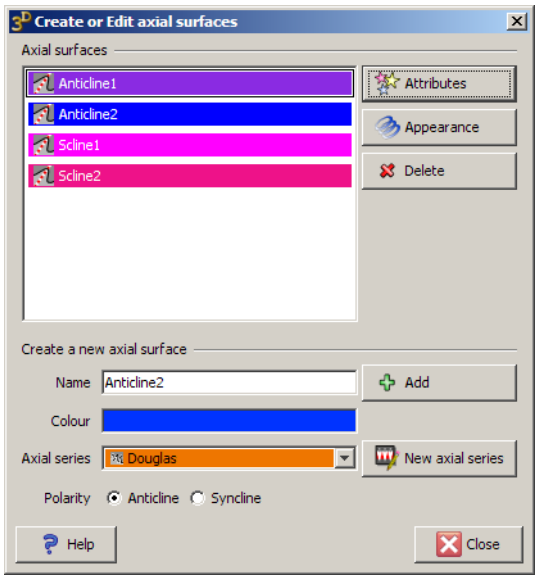
Create or Edit Axial Surfaces dialog box

Parent topic: Geology menu and dialog boxes

Create or edit axial surfaces



Controls in this dialog box

Control	Purpose
Axial surfaces	Axial surfaces in the project. Select (click) an axial surface for editing or deleting
Attributes	Edit the attributes of the selected axial surface. See Axial Surface Attributes dialog box.
Appearance	Edit the appearance of the selected axial surface. See Appearance of objects dialog box family.
Delete	Delete the selected axial surface.
Create a new axial surface	
Name	Name of a new axial surface
Colour	Click in this field to select colour for the new axial surface. Uses the Colour Palette dialog box.
Add	Add a new axial surface. Choose this after you have named it and selected the colour, axial series and polarity.
Axial series	Axial series to which the new axial surface belongs. Select from drop-down list.
New axial series	Create a new axial series for the new axial surface to belong to. See Create or Edit Axial Series dialog box.
Polarity	Whether the axial surface passes through an anticline or a syncline.

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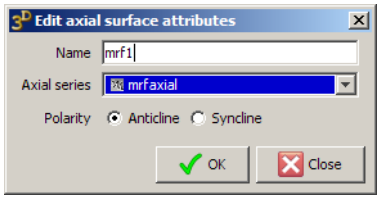
Axial Surface Attributes dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to edit the name or reselect axial series or polarity for an axial surface.



Controls in this dialog box

Control	Purpose
Name	Name of axial surface
Axial series	Axial series to which the axial surface belongs.
Polarity	Whether the axial surface passes through an anticline or a syncline.

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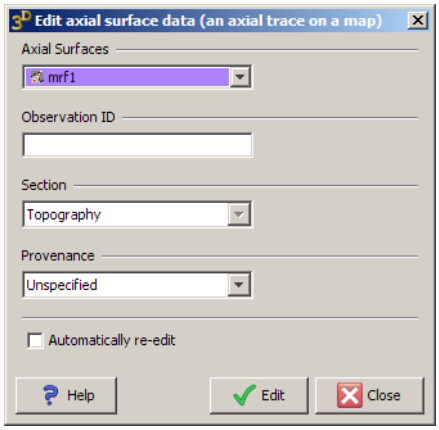
Create (or Edit) Axial Surface Data (an Axial Trace on a Map) dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to create or edit a set of axial surface data that marks the intersection between the axial surface and a section.



Controls in this dialog box

Control	Purpose
Axial surfaces	Axial surface associated with the axial surface data
Observation ID	Your label for the data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	The section containing the axial trace data points.
Provenance	Source of the geology data. See Provenance Editor dialog box to see the default settings or to create or edit new categories.
Automatically re-edit	When checked, 3D GeoModeller does not empty the **Points List** when you choose **Edit** or **Create**. This enables you to continue editing the data. See Editing geological data with the Points List for more information.

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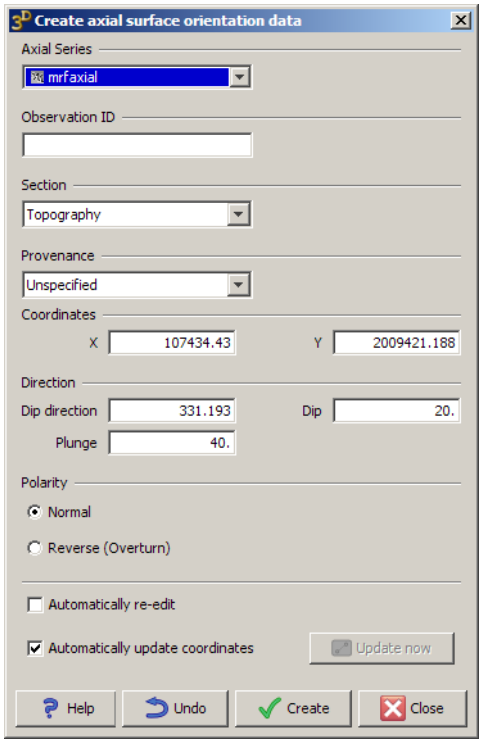
Create (or Edit) Axial Surface Orientation Data dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to enter or edit orientation data for axial surfaces.

Note that 3D GeoModeller associates the data with the whole axial series, not with any individual axial surface.



Controls in this dialog box

Control	Purpose
Axial series	Axial series associated with the geology orientation data
Observation ID	Your own reference number for this data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	Section containing the geology data points
Provenance	Source of the geology data. See Provenance Editor dialog box for the default settings or to create or edit new categories.
Coordinates: X, Y	u, v coordinates of the orientation point. This point is at the intersection of the baseline and pointer of the symbol. You can enter coordinates automatically from the **Points List**. See 'Automatically update coordinates' below in this table.

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Control	Purpose
Direction	**Dip** and **Dip direction** of the orientation point. See Orientation data plot symbols for further information. **Plunge** is the dip of the hinge line in the axial surface, showing an overall slope of the folded geology. You can enter **Dip direction** automatically from the **Points List**. See 'Automatically update coordinates' below in this table.
Polarity	If the geology at the orientation point is overturned, select **Reverse** If the geology is not overturned, select **Normal**. See Overturned geology.
Automatically re-edit	When checked, 3D GeoModeller does not empty the **Points List** when you choose **Edit** or **Create**. This enables you to continue editing the data. See Editing geological data with the Points List for more information.
Automatically update coordinates **Update now**	When checked, 3D GeoModeller automatically: • Updates **X** and **Y** with the coordinates of the most recent point in the **Points List** • Updates **Dip direction** with a direction that it calculates using the most recent two points in the **Points List** When not checked: • 3D GeoModeller does not automatically update **X**, **Y** and **Dip direction** from the **Points List**. • When you choose **Update now**, 3D GeoModeller updates **X**, **Y** and **Dip direction** from the **Points List**. as described above.

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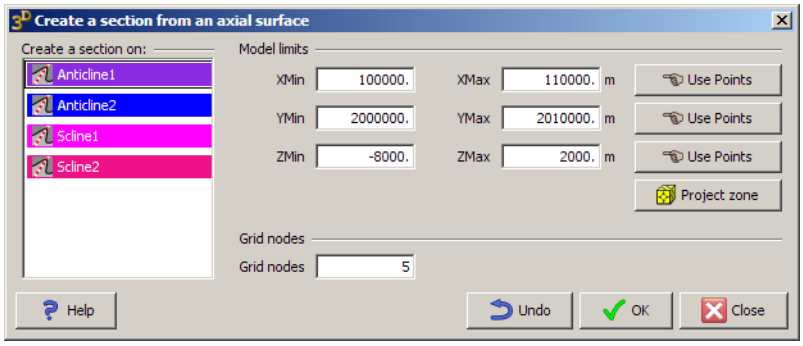
Create a Section from an Axial Surface dialog box

Parent topic: Geology menu and dialog boxes

3D GeoModeller normally requires that you create a section from an axial surface after you have defined it. You can specify the extents of the section.



Controls in this dialog box

Control	Purpose
Create a section on	Select the axial surface from which you want to generate the section
Model limits	Limits of the section extent in the project. Specify the extents **xMin**, **xMax**, **yMin**, **yMax**, **zMin**. You can: • Enter them manually • Enter dimension extents from the **Points List** • Specify the **Model limits** as whole project zone.
Use points	Uses the appropriate coordinate value (x, y or z) of the last (most recent) two points in the **Points List** as the **Min** and **Max**
Project zone	Sets the **Model Limits** to the full Project extents
Grid nodes	Contact our support service for information

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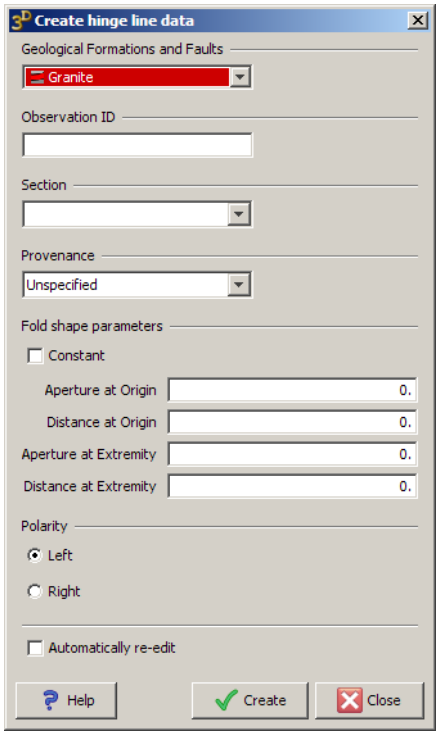
Create (or Edit) Hinge Line Data dialog box

Parent topic: Geology menu and dialog boxes

In a **2D Viewer** (of a section created from an axial surface), you can position points along a hinge line



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Controls in this dialog box

Control	Purpose
Geological formations and faults	Geology formation for these hinge line data points
Observation ID	Your label for the data. 3D GeoModeller provides this space for your notes. It does not use the data in calculations.
Section	Section containing the hinge line data
Provenance	Source of the geology data. See Provenance Editor dialog box to see the default settings or to create or edit new categories.
Fold shape parameters	
Constant	Check **Constant** if the distance and the aperture remain constant along the length of the hinge line. If the aperture and the distance vary along the hinge line between the two end values, clear **Constant** and enter the **Fold shape parameters**
Aperture at Origin	Aperture of the fold (in degrees) at the start of the hinge line (first point in the **Points List**)
Distance at Origin	Distance between the first point of the hinge line (first point in the **Points List**) and each of the associated orientation points that you are creating or editing
Aperture at Extremity	Aperture of the fold (in degrees) at the end of the hinge line (last point in the **Points List**)
Distance at Extremity	Distance between the last point of the hinge line (last point in the **Points List**) and each of the associated orientation points that you are creating or editing
Polarity	If the geology at the hinge line is overturned, select **Reverse**. If the geology is not overturned, select **Normal**. See Overturned geology.
Automatically re-edit	When checked, 3D GeoModeller does not empty the **Points List** when you choose **Edit** or **Create**. This enables you to continue editing the data. See Editing geological data with the Points List for more information.

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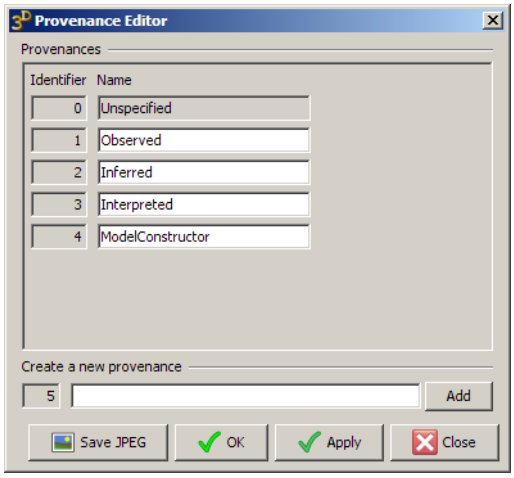
Provenance Editor dialog box

Parent topic: Geology menu and dialog boxes

Use this dialog box to specify the available provenances for your project. You can save an image of the dialog box showing the current settings.

The default 3D GeoModeller provenances are

- Unspecified
- Observed
- Inferred
- Interpreted
- ModelConstructor



Controls in this dialog box

Elements	Purpose
Identifier	Unique index number identifying each provenance
Name	Name of provenance
Create new provenance	To create a new provenance, enter new provenance name and choose **Add**
Save JPG	Save image of provenance table as a **`.jpg`** file

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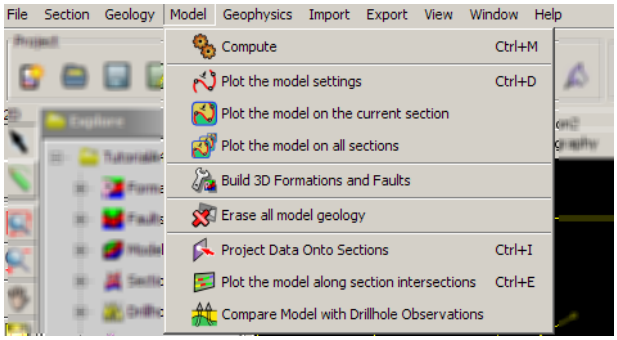
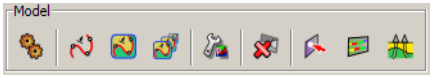
Model menu, toolbar and dialog boxes

Parent topic: 3D GeoModeller main menus

Use the **Model** toolbar options to calculate the model and specify how you want 3D GeoModeller to display the model.


File Section Geology Model Geophysics Import Export View Window Help
Compute Ctrl+M
Plot the model settings Ctrl+D
Plot the model on the current section
Plot the model on all sections
Build 3D Formations and Faults
Erase all model geology
Project Data Onto Sections Ctrl+I
Plot the model along section intersections Ctrl+E
Compare Model with Drillhole Observations



See the following table for an overview of the **Model** menu

Control	Purpose	Tools	Keys
Compute	See Compute The Model—Interpolate Geology and Structural Data dialog box. For model interpolation parameters, see Model Interpolation Parameters dialog box		CTRL+M
Plot the model settings	See Plot the Model Settings dialog box		CTRL+D
Plot the model on the current section	Plot the model on the currently selected section according to the current model settings (See Plot the Model Settings dialog box)		
Plot the model on all sections	Plot the model on all sections according to the current model settings (See Plot the Model Settings dialog box)		
Build 3D formations and faults	See Build 3D Formation and Fault Shapes dialog box		
Erase all model geology	Erase display of the model from the currently selected section.		
Project data onto sections	See Project data onto Sections dialog box		CTRL+I
Plot the model along section intersections	In the **2D Viewer**, display model geology colours along section intersections. This enables you to check agreement between sections.		CTRL+F
Compare model with drillhole observations	See Compare Model with Drillhole Observations dialog box		

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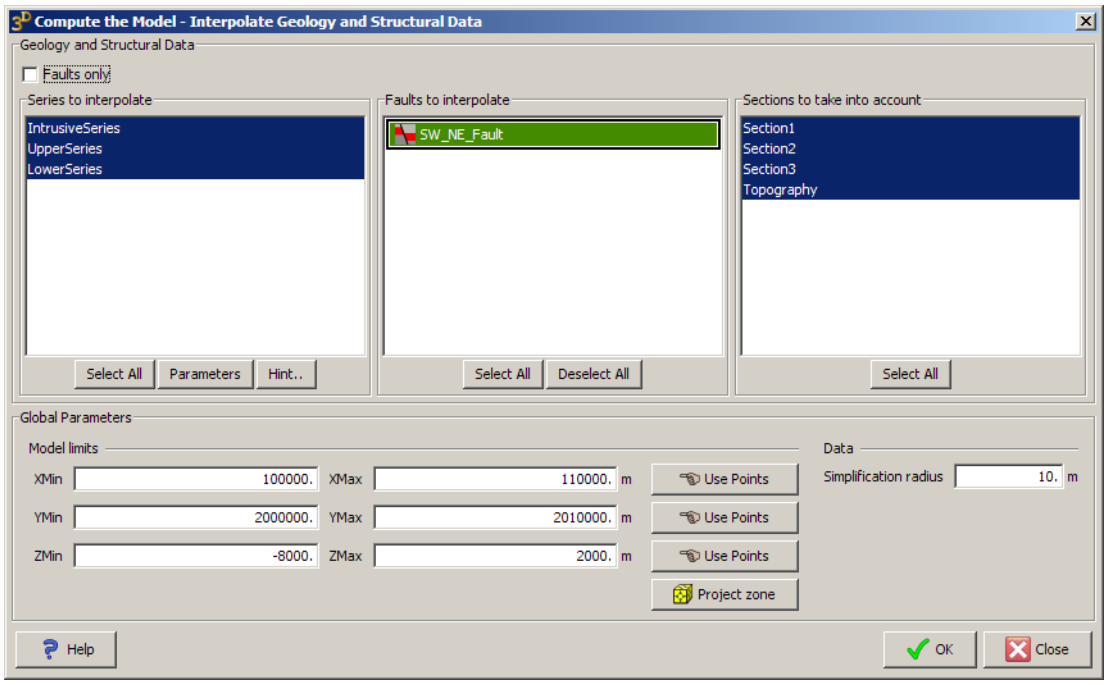
Compute The Model—Interpolate Geology and Structural Data dialog box

Parent topic: Model menu, toolbar and dialog boxes

Use this dialog box to:

- Select the project elements and the region of the project space that you want to include in the model calculation
- Using the **Simplification radius**, specify how much you want to reduce data density in the model calculation
- Calculate the model



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Controls in this dialog box

Control	Purpose
Faults only	Faults only: Check this in order to interpolate only the faults, regardless of the links between faults and series
Series to interpolate	Series available for the model calculation. Select (click) the series that you want to include in the model computation or use **Select All**. Hold down SHIFT or CTRL in the normal Windows manner to select a range or number of separate series. If **Faults only** is checked, the series are unavailable for inclusion in the model calculation
Select All	Include all series in the model calculation
Parameters	Set interpolation parameters for a series. This is only a when you select a single series. See Model Interpolation Parameters dialog box.
Hints	Reports on the reason for not listing certain series in this dialog box, for example
Faults to interpolate	Faults available for the model calculation. If **Faults only** is checked, you can select the faults to include in the model calculation. Select (click) the faults that you want to include in the model computation or use **Select All**. Hold down SHIFT or CTRL in the normal Windows manner to select a range or number of separate faults. If **Faults only** is not checked, 3D GeoModeller automatically includes faults were appropriate and you cannot select or deselect them individually.
Select All, Deselect All	If **Faults only** is checked, use these buttons to select all or deselect all faults
Sections to take into account	Sections available for the model calculation. Select (click) the sections that you want to include in the model calculation or use **Select All**. Hold down SHIFT or CTRL in the normal Windows manner to select a range or number of separate sections. As you select and deselect sections, 3D GeoModeller includes or excludes faults and series according to their presence in the sections that you are selecting.
Select All	Include all sections in the model calculation

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Control	Purpose
Model limits	Limits of the model calculation space in the project. Specify the extents **xMin**, **xMax**, **yMin**, **yMax**, **zMin**. You can: • Enter them manually • Enter dimension extents from the **Points List** • Specify the **Model limits** as whole project zone.
Use points	Uses the appropriate coordinate value (x, y or z) of the last (most recent) two points in the **Points List** as the **Min** and **Max**
Project zone	Sets the **Model Limits** to the full Project extents
Simplification radius	Control the density of project data to use in the calculation. Within the diameter that you specify (in metres), 3D GeoModeller averages out multiple data points to a single value. This enables 3D GeoModeller to operate faster in cases where you have dense data or you want to sacrifice model precision for speed of processing.

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Plot the Model Settings dialog box

Parent topic: Model menu, toolbar and dialog boxes

Use this dialog box to specify how you want 3D GeoModeller to plot the model on a section, including:

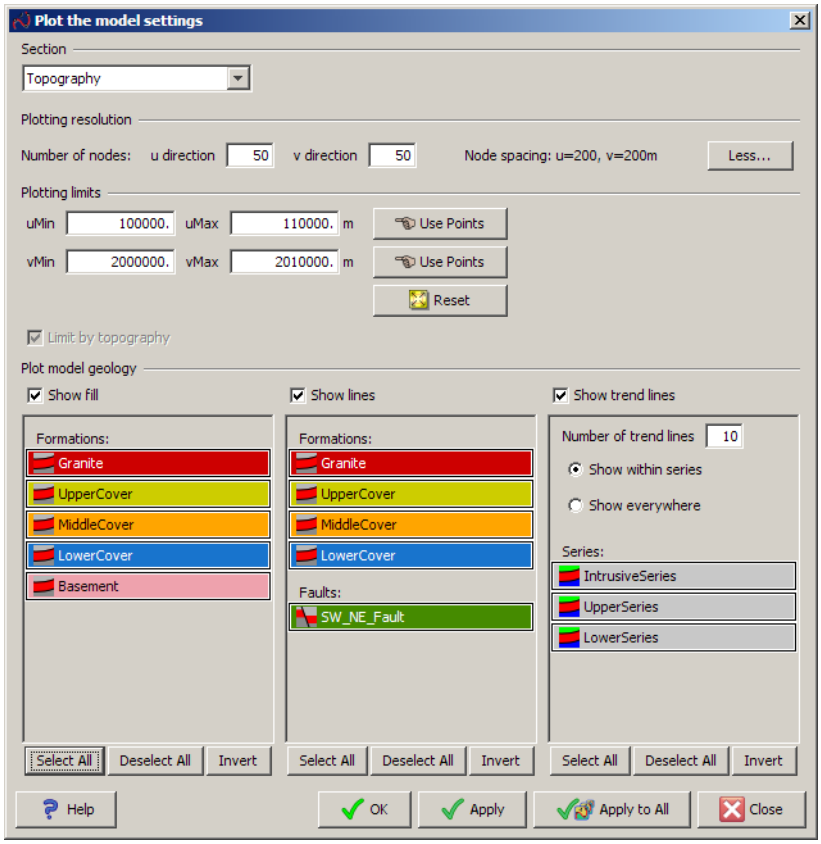
- Density of plot points along contact lines
- The region of the project space to plot
- Whether to plot lines, fill or trend lines or a combination, and which of them to plot

With this dialog box you can:

- Immediately apply settings to a selected section. 3D GeoModeller plots the model on the section according to your settings
- Immediately apply settings to all sections. 3D GeoModeller plots the model according to your settings

When you close the dialog box, 3D GeoModeller remembers the settings. When you plot the model on a section or on all sections, 3D GeoModeller uses the settings that were in the dialog box when you closed it.

Note: Currently, if you set plotting limits in a section, as soon as you select a different section in the dialog box or the **2D Viewer**, 3D GeoModeller restores the plotting limits for that section to the project extents.



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Controls in this dialog box

Control	Purpose
Section	Section to which you want to apply the current settings
Plotting resolution	3D GeoModeller applies a mesh (grid) to the section to determine the level of plot detail. You can specify the number of nodes (cells) in each dimension of the section. 3D GeoModeller assigns a different value from the model to each node or cell and then smoothly fills the gaps between them. If you specify a finer mesh (larger number of nodes), you will get a more detailed result, but it will take longer to draw it. If you specify plotting limits, 3D GeoModeller divides the areas within the plotting limits according to the mesh that you specify. Hence, if you specify 50 by 50 nodes (cells), 3D GeoModeller divides the area defined by the plot limits into 50 by 50 nodes (cells).
More, Less	Show (**More**) or Hide (**Less**) the **Plotting limits** panel
Plotting limits	Limits of the model plotting space in the section. Specify the extents **uMin**, **uMax**, **vMin**, **yMax**, **vMin**. You can: • Enter them manually • Enter dimension extents from the **Points List** • Specify the **Plotting limits** as the section extent.
Use points	Uses the appropriate coordinate value (u or v) of the last (most recent) two points in the **Points List** as the **Min** and **Max**
Reset	Sets the **Plotting Limits** to the section extent
Limit by topography	When checked, 3D GeoModeller does not plot any model data above the topography in a section.
Plot model geology	
Show fill	When checked, 3D GeoModeller plots the selected formations using filled polygons in their assigned colours.
Formations	Formations available for plotting. See How to select items from a list.

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Control	Purpose
Show lines	When checked, 3D GeoModeller plots: • The interface or contact lines of the selected geology formations in the assigned colours of the formations (according to the **Top** or **Bottom** setting for the series to which they belong). See Create or Edit Geology Series and the Stratigraphic Pile dialog box. • The selected faults in their assigned colours
Formations, Faults	Formations and faults available for plotting. See How to select items from a list.
Show trend lines	When checked, 3D GeoModeller plots geology trend lines for the selected series in the assigned colours of the formations through which they pass. Trend lines are contours based on the model's isopotential curves.
Number of trend lines	Specify the number of trend lines to plot for each series
Show within series	When checked, 3D GeoModeller plots trend lines only within the series to which they belong
Show everywhere	When checked, 3D GeoModeller plots the specified number of trend lines for each selected series, but spreads them evenly through the whole plot area
Series	Series available for trend line plotting. See How to select items from a list.
OK	Plot the model on selected section in **2D Viewer** and then close the dialog box
Apply	Plot the model on selected section in **2D Viewer**
Apply to all	Plot the model on all sections in **2D Viewer**
Close	Close the dialog box without plotting the model, but retain the settings for use with **Plot the model on a section** and **Plot the model on all sections**

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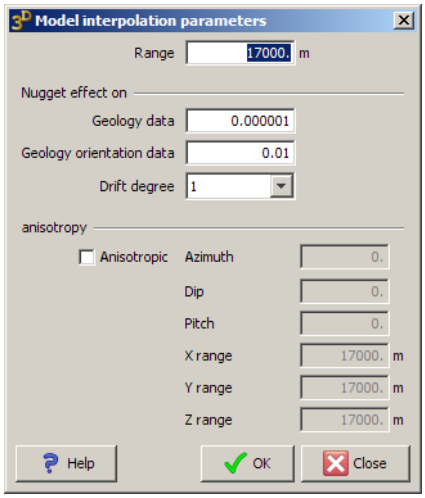
Model Interpolation Parameters dialog box

Parent topic: Model menu, toolbar and dialog boxes

Use this dialog box to control how 3D GeoModeller interpolates data associated with a series when calculating the model.

For a detailed explanation and examples, see Model interpolation parameters.

To display this dialog box, in the **Compute The Model—Interpolate Geology and Structural Data** dialog box, select the series required and choose **Parameters**. See Compute The Model—Interpolate Geology and Structural Data dialog box.



Controls in this dialog box

Control	Purpose
Range	Zone of influence for contact and orientation data points. Beyond the **Range**, a data value has no influence on the model calculation. The default value is the length of the diagonal of the bounding box of the project.
Nugget Effect on	
Geology Data	Balance of model smoothness against honouring the contact data. The larger the value, the smoother the model and the less 3D GeoModeller honours the contact data.
Geology Orientation Data	Balance of model smoothness against honouring the orientation data. The larger the value, the smoother the model and the less 3D GeoModeller honours the orientation data.
Drift Degree	
Anisotropy	The anisotropy definition consists of: • A set of 3D axes with defined ranges of influence in each dimension. • Angles of rotation of the set of axes that defines the anisotropy

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Control	Purpose
Azimuth	The default **Azimuth** of 0 is north, the direction of the +Y axis. A positive **Azimuth** rotates the Y axis in a clockwise direction around the Z axis, in the horizontal plane.
Dip	The angle of downward rotation of the Y axis in the direction of the azimuth of the +Y axis. **Dip** is positive down in this direction in 3D GeoModeller, not negative as defined in GSLIB (see diagrams in Model interpolation parameters).
Pitch	The third rotation angle, **Pitch**, leaves the principle direction or vector defined by **Azimuth** and **Dip** unchanged. The two directions perpendicular to the principle vector are rotated clockwise relative to the principle vector when looking towards the origin. The **Pitch** rotation appears to be anticlockwise since the view is away from the origin. See diagrams in Model interpolation parameters.
X Range	Range (in metres) in the 'X' dimension of the axes that define the anisotropy
Y Range	Range (in metres) in the 'Y' dimension of the axes that define the anisotropy
Z Range	Range (in metres) in the 'Z' dimension of the axes that define the anisotropy

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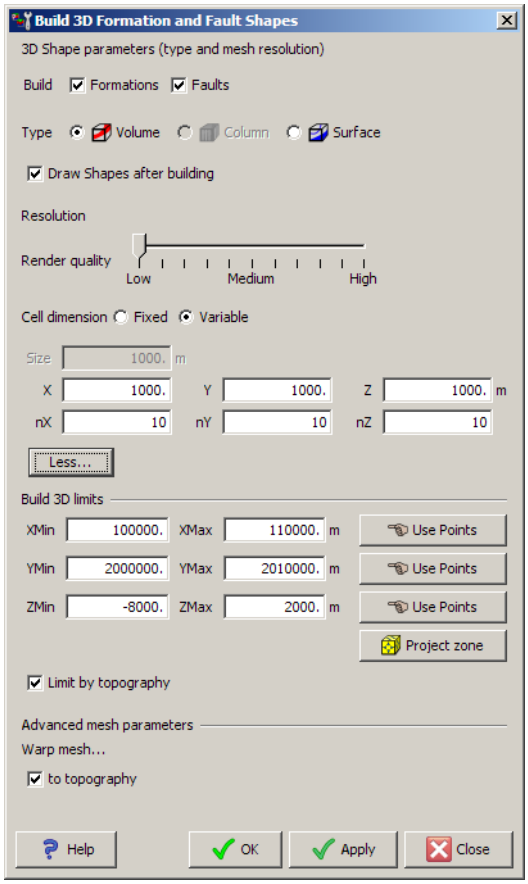
Build 3D Formation and Fault Shapes dialog box

Parent topic: Model menu, toolbar and dialog boxes

Use this dialog box to specify the appearance and components of the display in the **3D Viewer**. You can:

- Include or exclude formations and fonts
- Build the 3D display as volume, columns or a surface
- Specify resolution, cell size and render quality
- Specify the region of the project area to plot and the appearance of the topographic surface



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Controls in this dialog box

Control	Purpose
Build	Build 3D **Formations** or **Faults** or both so that they are available for display
Type	Build formations as **Volumes** (a (closed) volume) or **Surfaces** (a series of geology interfaces or surfaces) only. Faults are always built as surfaces. For a quick display of formations only, as an assemblage of 'columns' or vertical parallelepipeds, select **Columns**.
Draw shapes after building	When checked, display shapes in **3D Viewer** after calculating them
Resolution: Render quality	Resolution of the sampling grid. Higher resolution yields more detail but requires more time and memory.
Cell dimension	**Fixed**: 3D GeoModeller renders the model in cells of fixed size **Variable**: 3D GeoModeller renders the model in cells whose size you specify
Size	*(If you selected **Cell dimension: Fixed**)* Size of rendered cells in metres
X, Y, Z	*(If you selected **Cell dimension: Variable**)* Dimensions of rendered cells in each dimension, in metres. If you change **nX**, **nY**, **nZ**, 3D GeoModeller adjusts these automatically.
nX, nY, nZ	*(If you selected **Cell dimension: Variable**)* Numbers of rendered cells in each dimension within the **Build limits**. If you change **X**, **Y**, **Z**, 3D GeoModeller adjusts these automatically.
Build 3D limits	
Limit by topography	When checked, 3D GeoModeller only displays the 3D model within the topographic surface.
Advanced mesh parameters: Warp mesh to topography	When checked, 3D GeoModeller displays the mesh warped so that it follows the topographic surface. When clear, 3D GeoModeller displays the mesh as straight lines parallel to the axes. If you check **Limit by topography**, the lines of mesh end abruptly at the topographic surface

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Project data onto Sections dialog box

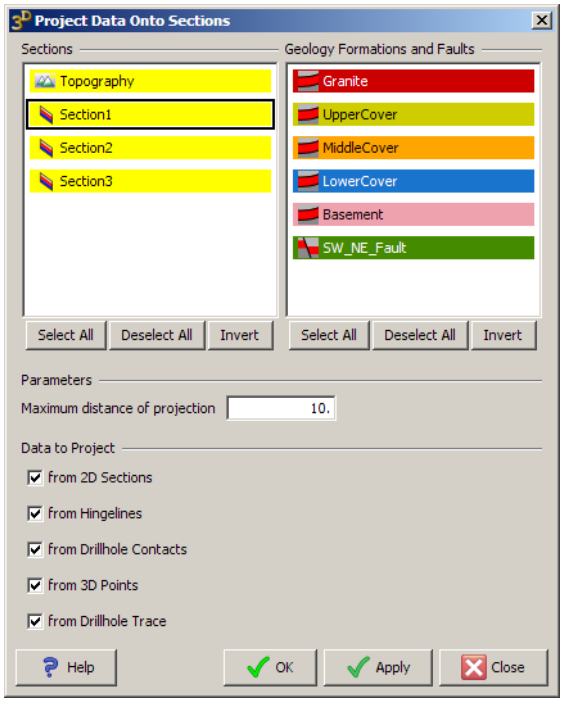
Parent topic: Model menu, toolbar and dialog boxes

Data that is not on a section, such as drillholes or imported 3D data, would not normally be visible in the **2D Viewer**. It may be useful, too, to be able to see the collective data from close-by sections all together on one section.

You can project data onto a nearby section so that you can see it.

Use this dialog box to select:

- The sections onto which to project the data
- The formations whose data you want to project
- The distance from the section beyond which 3D GeoModeller will not project data
- The type of data to project



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Controls in this dialog box

Control	Purpose
Sections	Sections onto which you can visually project data. Select one or more.
Geology formations and faults	Geology formations and faults whose data you can visually project onto sections. Select one or more.
Maximum distance of projection	Data needs to be within this distance of the section to be visually projected.
Data to project	Types of data to project. Select the data types using the check boxes.

Compare Model with Drillhole Observations dialog box

Parent topic: Model menu, toolbar and dialog boxes

Use this dialog box to set parameters for comparing the model formations with drillhole data. 3D GeoModeller displays special symbols above drillholes whose data do not match the model formations.

Controls in this dialog box

Control	Purpose
Precision	Maximum allowable distance along the drillhole between the drillhole contact and the model contact
Compare	Perform the comparison

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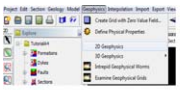
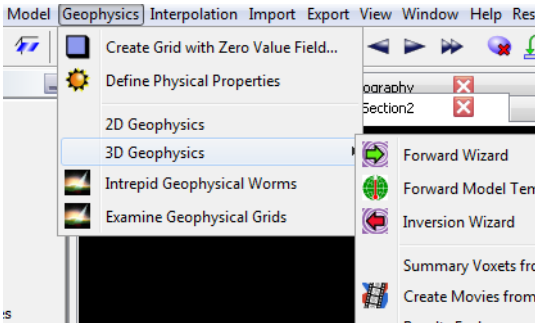
Geophysics menu and dialog boxes

Parent topic: 3D GeoModeller main menus

Use the **Geophysics** menu items to configure and performs geophysical processing in the project space.





See the following table for an overview of the **Geophysics** menu

Element	Description
Create zero value field	See Geophysical Grid Definition dialog box
Define physical properties	See Physical Properties of Geological Formation dialog box
2D Geophysics	Forward modelling from geophysical data within a line or model slice. See Computing a 2.5D forward model.
(2D) Seismic	Create a synthetic seismograph
(2D) Gravity	Forward model a gravity profile for a section. See Computing a 2.5D forward model.
(2D) Magnetic	Forward model a magnetism profile for a section. See Computing a 2.5D forward model.
3D Geophysics	Accounting for geophysical observations in the X, Y and Z dimensions
Forward model	*(Gravity)* Forward models a vertical gravity anomaly or tensor components using geology volumes and associated rock properties. *(Magnetism)* Forward models total magnetic intensity or tensor components using geology volumes and associated rock properties.
Forward model temperatures	Computes 3D temperature based on geology volumes and associated rock properties
Potential field inversion	See Forward modelling and inversion with 3D GeoModeller.
Create movies from inversion	
Create set of inversion movies	

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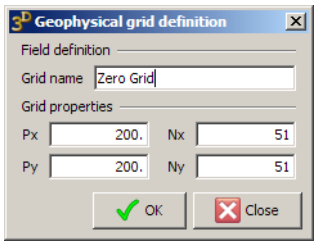
Element	Description
Intrepid geophysical Worme	Launch the INTREPID Multi-scale edge detection wizard
Examine geophysical grids	Launch the INTREPID Visualisation tool

Geophysical Grid Definition dialog box

Parent topic: Geophysics menu and dialog boxes

Set up a regular orthogonal grid of zero values as a reference for the forward model. It is defined by number and size of cells in X and Y.



Controls in this dialog box

Control	Purpose
Field definition	
Grid name	Grid title
Grid properties	**Px**, **Py**: Cell size in metres in each dimension **Nx**, **Ny**: Number of cells in each dimension

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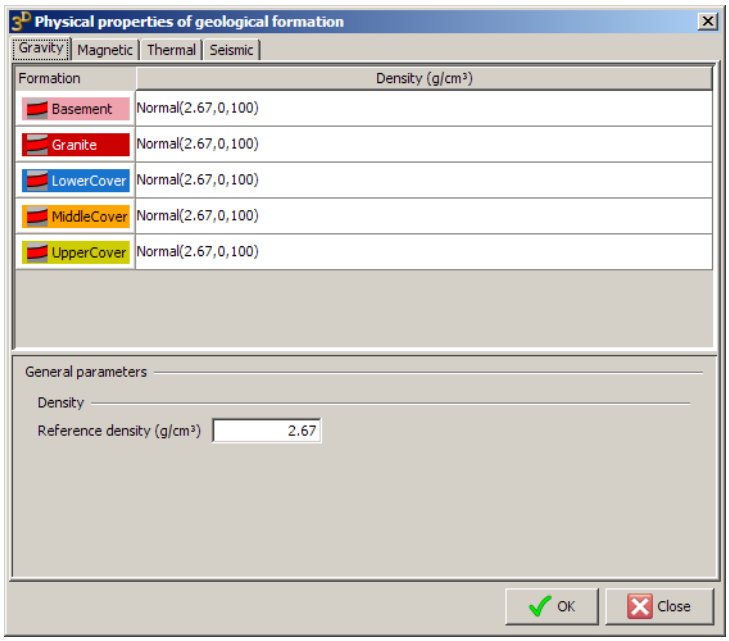
Physical Properties of Geological Formation dialog box

Parent topic: Geophysics menu and dialog boxes

A group of tables in which you can assign physical rock properties for each formation.



Operations that use this dialog box

- Geophysics operations

Controls in this dialog box

Control	Purpose
Gravity	Density distribution law for each formation
Magnetic	Susceptibility and remnant magnetisation distribution laws for each formation
Thermal	Thermal conductivity and heat production rate distribution laws for each formation
Seismic	Velocity distribution law for each formation

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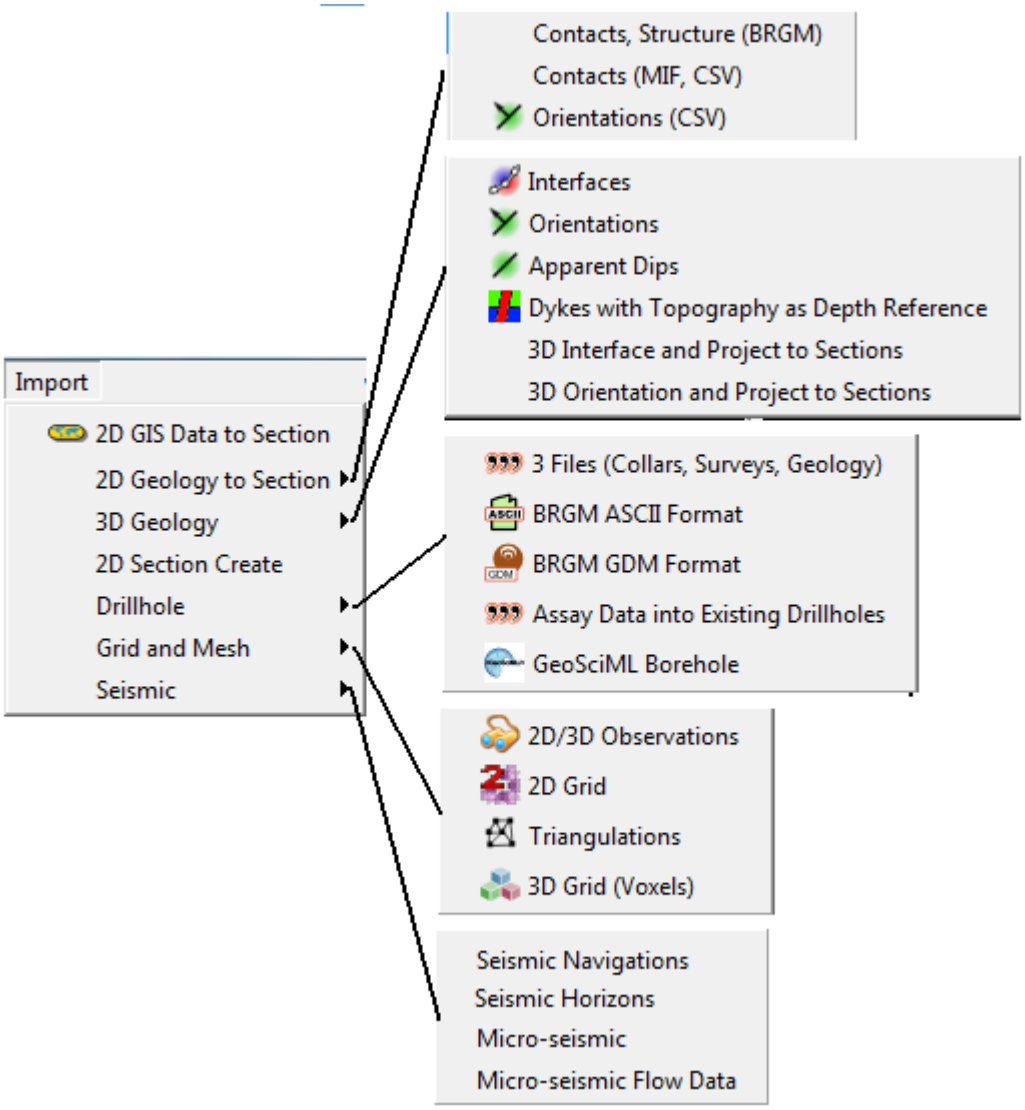
Import menu and dialog boxes

Parent topic: 3D GeoModeller main menus

Use **Import** menu items illustrated below to import data from supported formats into your 3D GeoModeller project.



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See the following table for an overview of the **Import** menu

Control	Purpose
Import 2D GIS Data to Section	Import 2D GIS data into the topographic section See Importing GIS and other binary located data
Import 2D Geology to Section	Import 2D contacts, structure and orientation data in BRGM, MIF and ASCII formats. See Import 2D Geology to Section Submenu Options
Import 3D Geology	Import 3D formations, dykes, faults and orientation data in CSV format using the **CSV data import wizard**. See Import 3D Geology Submenu Options and CSV data import wizard Choose to project data onto the nearest section and permanently associate it with the section. Select sections and maximum projection distances.
Import 2D Section Create	Import a series of points and automatically create multiple vertical cross-sections within your *GeoModeller* project, see Import 2D Section Create.
Import Drillhole	Import drillhole data in 3 file CSV format using the **CSV data import wizard**. For detailed instructions, see Import Drillhole and Importing drillholes and drillhole geophysical logs and assays
Import Grid and Mesh	Import 2D and 3D Observations, 2D Grids, 2D and 3D Triangulations and 3D Grids/Voxets, see...
Import Seismic	Import Seismic Navigation data and Horizon picks or Import a Micro-seismic 3D point cloud with attributes and a Micro-seismic Flow rate database, see Import Seismic

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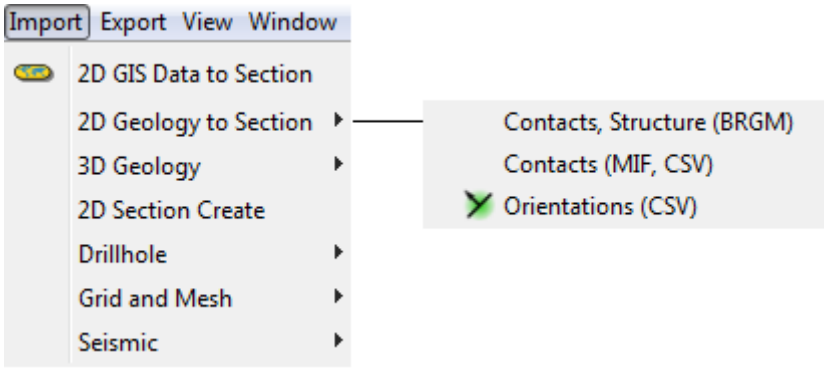
Import 2D Geology to Section Submenu Options

Parent topic: Import menu and dialog boxes



If you have 2D contacts (shapes) or orientations (geometry - dip/dip-direction) created with other software, you can import the graphic objects into 3D GeoModeller. When you import the 2D data to the Surface Topography section the imported locations are assigned the DTM elevation at each location - x,y coordinate.

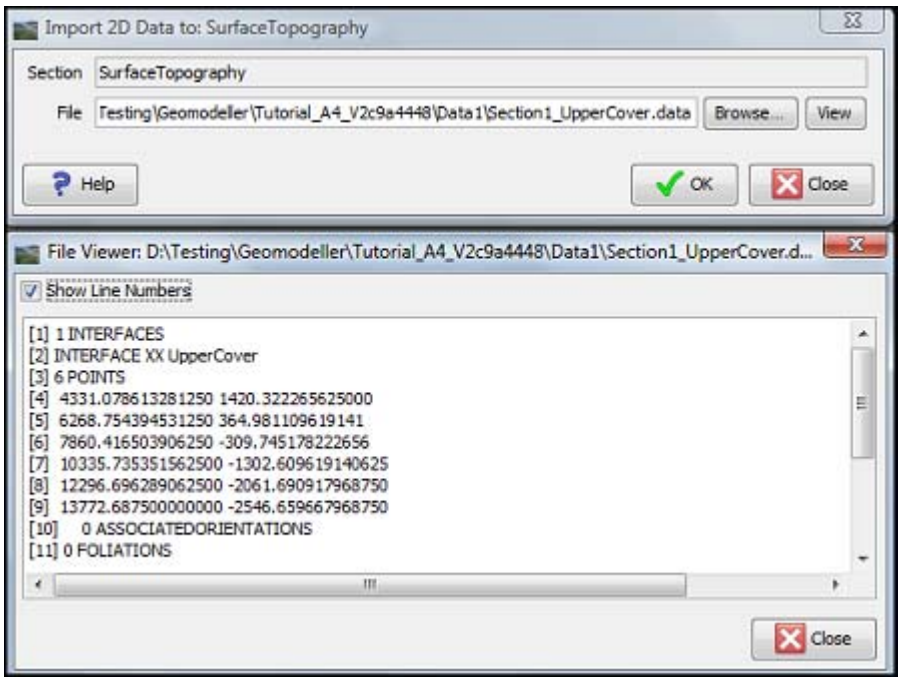
Available formats for 2D Contacts and Orientation Data

- ASCII (BRGM)
- MIF MID (MapInfo) See MapInfo import Dialog
- ASCII (CSV) See CSV data import wizard

Submenu Item 1

- **Contacts, Structure (BRGM)**

  Use this dialog box to select the section to which you want to import data and the data file from which to import the data. You can preview the data in the import file before importing it. The data will be in ASCII BRGM format (see ....).



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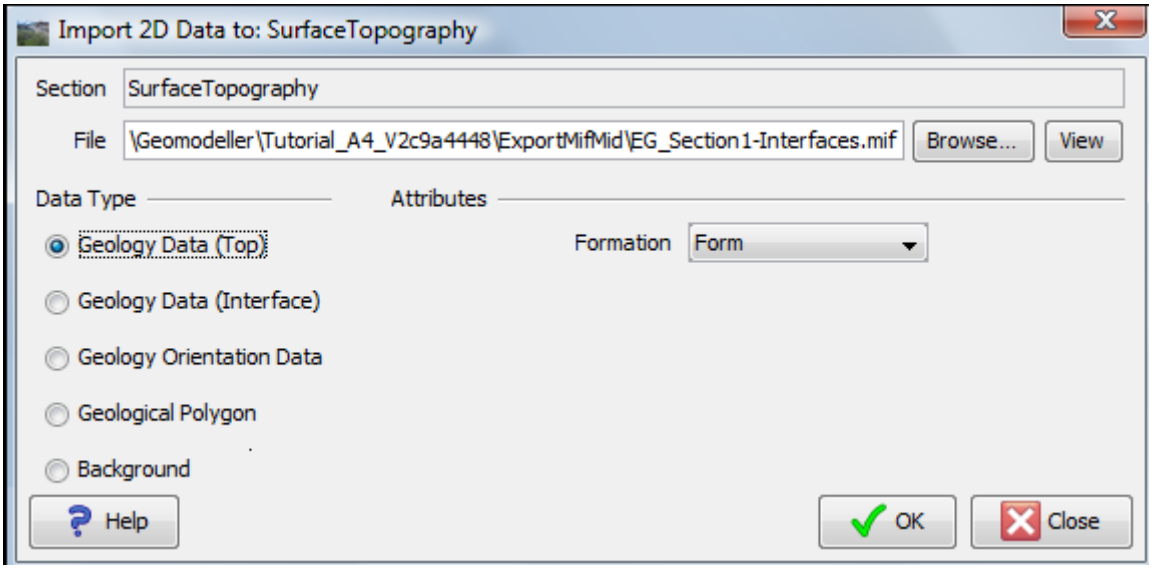
Controls in this dialog box

Control	Purpose
Section	Section onto which to import the data
Browse, File to load	Import file
View	Preview the import file with or without line numbers.

Submenu Item 2

- **Contacts, Structure (MIF,CSV)**

  Use the previous **Import 2D Data** dialog box to select the section and the data file from which to import the data. If you select a MIF/MID format file then you will see the following dialog



Choose the Data Type required for import and the Attribute(s) in the Mid file containing the Formation name or other attributes required for Orientation or other data types as shown in the table and dialogs below.

Data Type	Attribute1	Attribute2	Attribute3	Attribute4
Geology Data (Top)	Formation			
Geology Data (Interface)	Formation Right	Formation Left		
Geology Orientation Data	Formation	Dip	DipDirection	Polarity
Geology Polygon	Formation			
Background				

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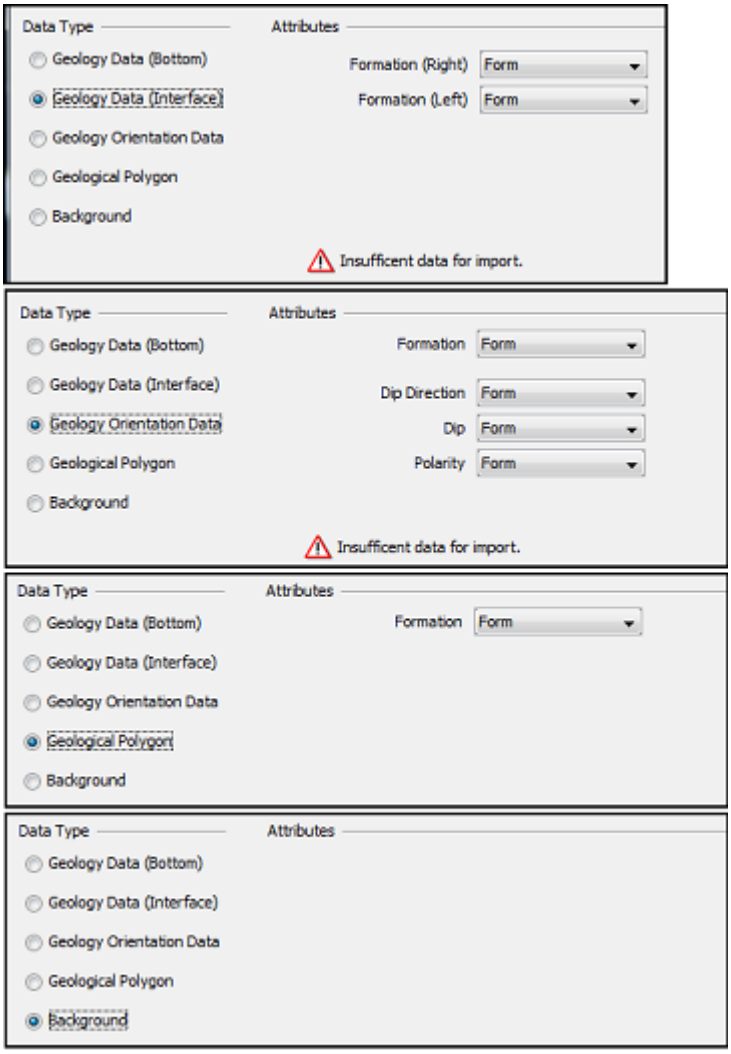

If you select a CSV format file then you will see the standard CSV import dialog and at Step 3 you will be required to select the columns containing the Formation or Fault name and the East and North coordinates.

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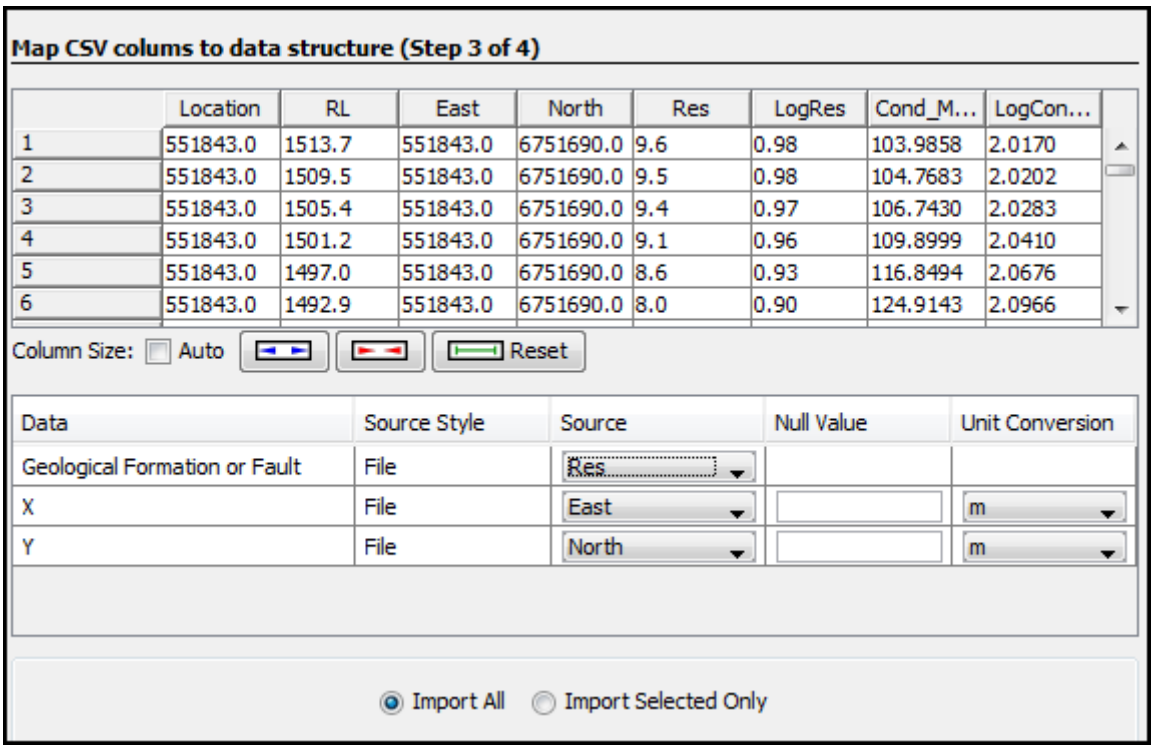
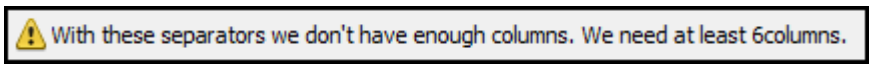


Submenu Item 3

- **Orientations (CSV)**

  Selecting this submenu option opens the CSV import wizard (See CSV data import wizard—Parse import file). The selected file must contain at least 6 columns or the importer will report an error



  Otherwise the final dialog will appear as shown below and the user must select the columns containing the following variables.

Data	Source Style
Formation	File (Column in File), Project (Choose a Fm from the project), User (Type in the Fm name)
X	File (Column in File only)
Y	File (Column in File only)
Direction	Strike (Column in File only)
Dip	Dip (Column in File only)
Polarity	File (Column in File) or User (Type in the polarity used [0 or 1; normal or reverse)

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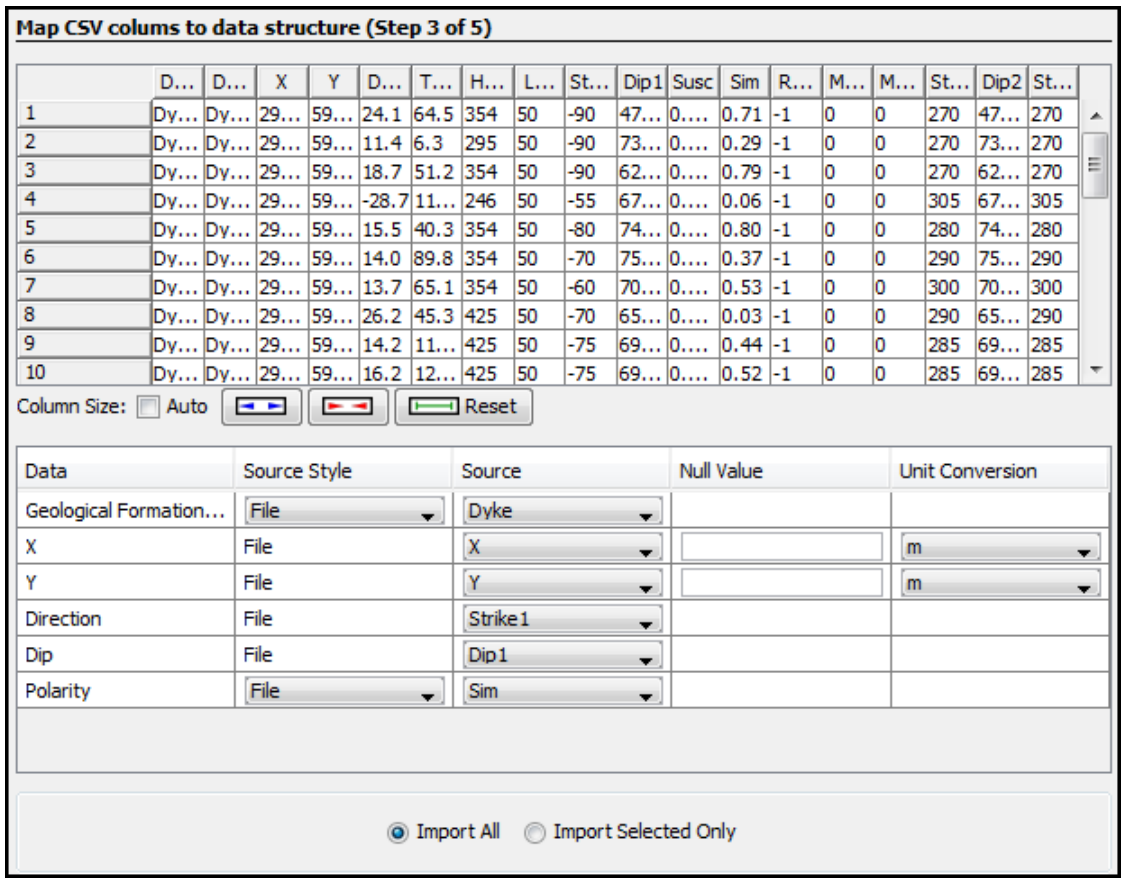
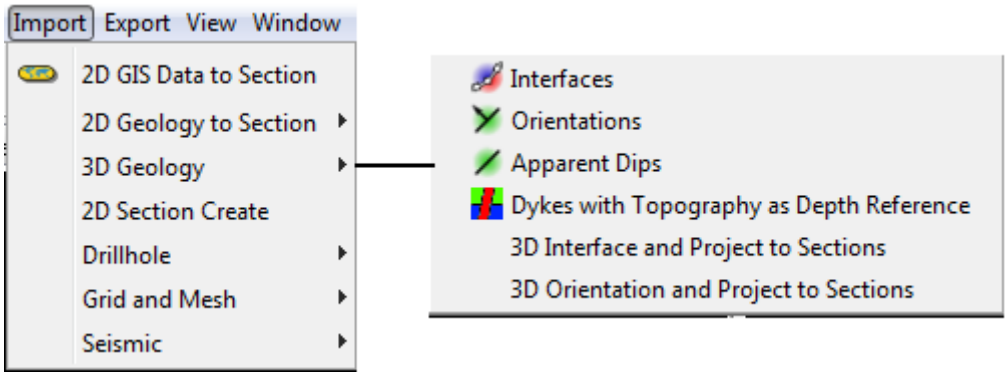


Import 3D Geology Submenu Options



As indicated by the submenu menu options above the following methods are available for importing 3D data into *3D GeoModeller*. All of these import options are handled by the CSV Import wizard, see CSV data import wizard.

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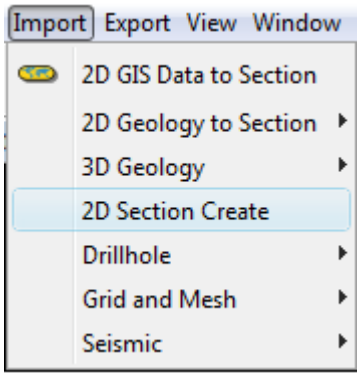
SubMenu Option	Description
3D Interface	Import geology contact data associated with selected formations and faults. This data remains in 3D space and is not visible on a section unless it is exactly on the section or you project it onto the section.
3D Orientations	Import geology orientation data associated with selected formations and faults. This data remains in 3D space and is not visible on a section unless it is exactly on the section or you project it onto the section.
Apparent Dips	Import 3D Apparent Dip data (ie from 2D Seismic sections)
Dykes with Topography as Depth Reference	Import 3D Dykes derived from Intrepid's Naudy AutoModeller
3D Interface and Project to Sections	Import geology contact data associated with selected formations and faults. Project it onto selected sections and permanently convert it from 3D data to data associated with these sections. Select a maximum projection distance.
3D Orientation and Project to Sections	Import geology orientation data associated with selected formations and faults and project to nearest section. Select a maximum projection distance.

These datatypes are discussed in more detail in the manual under **2D and 3D Meshes and Grids In 3D GeoModeller**

Import 2D Section Create



This option allows the user to to automatically create vertical cross-sections in a *GeoModeller* project by importing multiple series' of points and section attribute labels in a CSV format.

An example of the required CSV file format is shown below (in this case each pair of points defines a cross-section):

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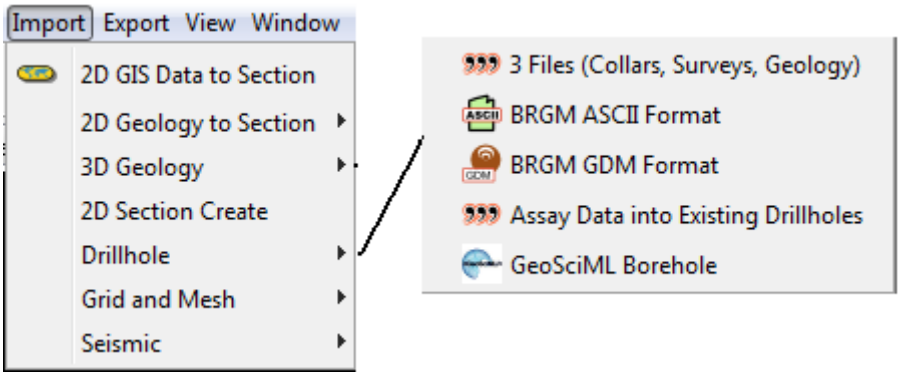
```
Section,East,North
10032N,551843,6751690
10032N,554718,6751690
10041N,551834,6751395
10041N,554757,6751395
10051N,551839,6751090.5
10051N,554757,6751090.5
```

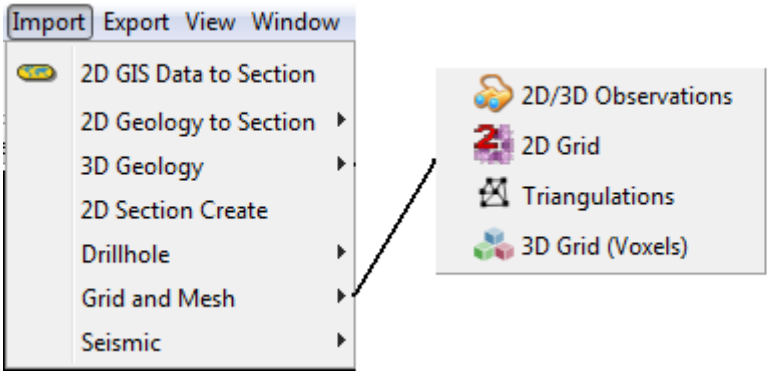
The CSV import wizard is used to parse the file. The vertical cross-sections created have the full vertical extent of the *GeoModeller* project.

Import Drillhole



For all details see: Importing drillholes and drillhole geophysical logs and assays

Import Grid and Mesh



This option allows the user to import 2D and 3D Observations, 2D Grids, 2D and 3D Triangulations and 3D Grids/Voxets as shown in the following table.

SubMenu Option	Function
2D/3D Observations	Import surface, airborne - geochemical, geophysical data in CSV format using the **CSV data import wizard**. For information about the wizard, see CSV data import wizard

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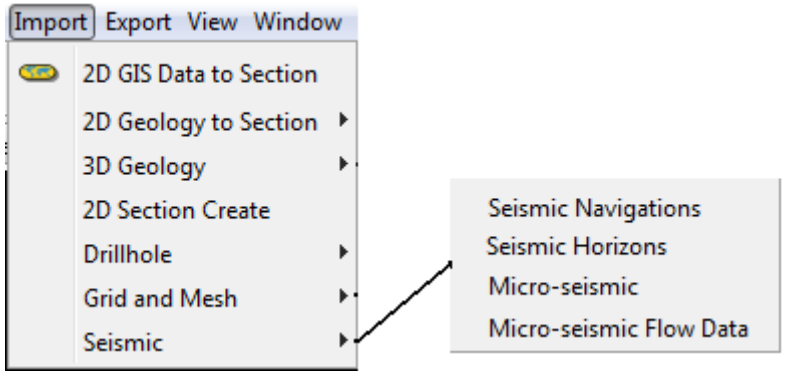
SubMenu Option	Function
2D Grid	Import geophysics, geochemistry, elevations, isopachs 2D grids available supported formats
Triangulations	Import 2D surface triangulations or 3D triangulations of volumes into a Mesh from available supported formats such as GoCAD TSurf, DXF, or Vulcan wireframe
3D Grid (Voxels)	Import 3D regular grids of such data as Geology, Densities, Susceptibilities using available supported formats such as GoCAD Voxet

Import Seismic



These options allow the user to import Seismic Navigation data and Horizon picks or to import a Micro-seismic 3D point cloud with attributes and/or a Micro-seismic Flow rate database as described in the following table

SubMenu Option	Description
Import Seismic Navigations	Import seismic navigation data in fixed format using the **CSV data import wizard**. For information about the wizard, see Navigation Import
Import Seismic Horizons	Import seismic horizon picks in fixed format using the **CSV data import wizard**. For information about the wizard, see Horizon Import
Import Micro-seismic	Import micro-seismic data in CSV format using the **CSV data import wizard**. For information about the wizard, see CSV data import wizard
Import Micro-seismic Flow Data	Import micro-seismic flow data in CSV format using the **CSV data import wizard**. For information about the wizard, see CSV data import wizard

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Importing Seismic Navigation and Horizon Data

Overview:

The Seismic Import tool provides a convenient way to bring both seismic navigation and interpreted horizon pick data into Geomodeller. A two step procedure is used where seismic navigation data is imported as a first step, followed by interpreted horizon pick data. The two step procedure was chosen as it is expected that navigation data will change less frequently than the interpreted horizon picks.

Navigation data is imported as a section in Geomodeller for each seismic line. Horizon picks are imported as 3D contact data with each horizon corresponding to a different formation in Geomodeller. True-dip orientation data is calculated automatically from seismic line intersections by fitting a plane to all points within a specified radius of an intersection from which the dip and dip-direction are calculated. This is then imported into Geomodeller as 3D orientation data.

Data files are Intrepid databases which can be converted from plain ASCII text files via the ImportAscii tool or the Geomodeller CSV ASCII import wizard.

Data Constraints:

A seismic line must be fully defined within a single file.

Data files must contain a unique set of seismic lines. Each line will appear once and once only in the entire set of data files.

Summary:

The following points summarise the important aspects of the Seismic Import tool.

- Navigation and Horizon data are imported in two separate import steps.
- Navigation and Horizon data from each seismic line must not be split over multiple files.
- Horizon import requires the navigation data to be available.
- The shot-id is used to look up the LAT/LON or UTM coordinates for each horizon pick in the navigation database files.
- Data is thinned before importing to Geomodeller using a Ramer-Douglas-Peucker like algorithm (See below)
- All processing such as line intersection calculations, true-dip orientation etc. is done on the full dataset, not the thinned data
- True-dip is calculated at seismic line intersections during the horizon pick import.

Data Thinning:

In order to import dense seismic data into Geomodeller it must be thinned. This is an automated processed which will search for the best N points that match the dataset. The final N points will best match the data according to the runime behaviour of the Ramer-Douglas-Peucker algorithm

http://en.wikipedia.org/wiki/Ramer%E2%80%93Douglas%E2%80%93Peucker_algorithm.

The best N points can be defined by the user, however, the defaults are generally sufficient.

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Note: Geomodeller is designed to work extremely well with sparse data. Thinning the large number of horizon picks from the input data is often beneficial for performance and the resulting model.

Navigation Import

The navigation import is used to create a Geomodeller section for each seismic line. During this step additional information is gathered in order to streamline the horizon pick import stage. Line intersections are recorded to alleviate the need to recalculate every time horizon pick data, that corresponds to the navigation data, is imported.

The intersections are by default stored in temporary files but the user may be specify a file in order to reuse the data later. This is handy when one needs to perform multiple horizon pick imports using the same navigation data.

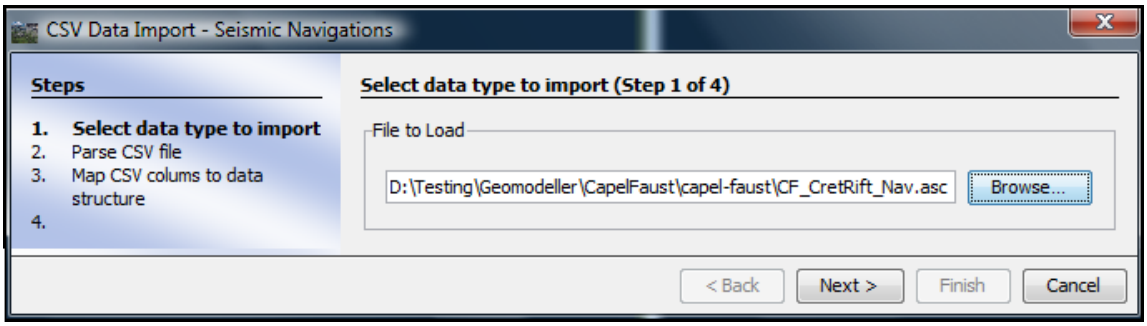
During the horizon pick import a look up into the navigation data files is required. This look up uses the SHOTPOINT and LINE-ID as a key to obtain the coordinates for each interpreted pick point.

1 The first step is to setup a new GeoModeller project with the correct datum/ projection and extents to cover the area of the seismic traverses. A suitable DTM or bathymetry surface should also be loaded

2 To commence the import of navigation data choose:

Import-> Seismic->Seismic Navigations option from the *3D Geomodeller* main menu and select the fixed format ascii navigation file to import.

Wizard Step 1:



3 Click **Next->** to move to next Page.

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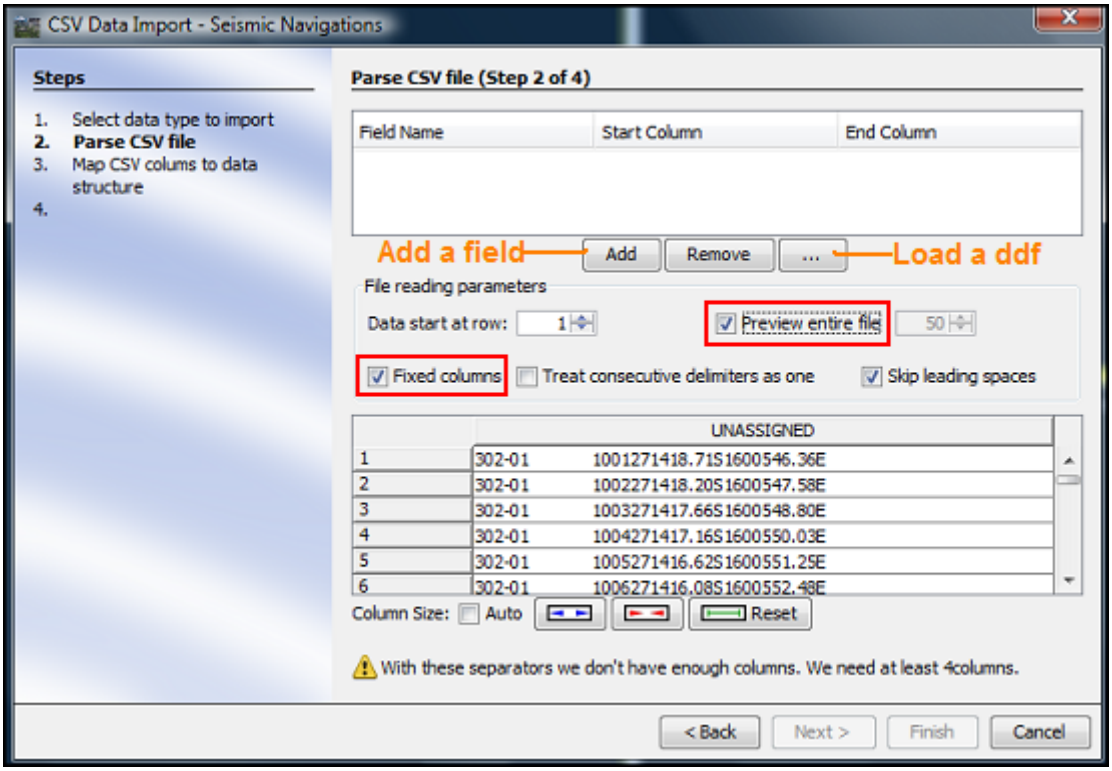
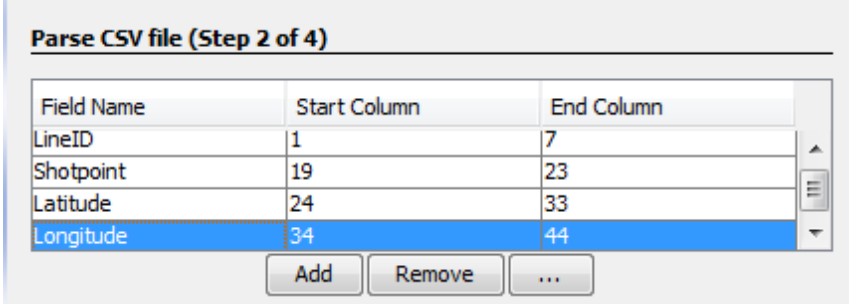


Wizard Step 2:

4 Set the file format to **Fixed Columns** and select **Preview entire file**

5 Click **Add** to add a field then enter the fixed format column positions for each variable. Use an editor to obtain the column positions before the import run. Do not attempt to edit the automatic column position for last field as this usually corrupts the previous field and turns the previous field rows red.



The fields required for the navigation import and their possible data types are listed in the table below

Field	Description	Data type
Line	The Seismic line identifier which becomes the section name in GeoModeller	alpha numeric
Shotpoint	Shotpoint number used to map coordinates to Formation picks (may be a decimal number - interpolated between shotpoints)	numeric
X	X coord of the Shotpoint (Longitude or East)	numeric - one char if DMS
Y	Y coord of the Shotpoint (Latitude or North)	numeric - one char if DMS

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The X and Y coordinates may be projected (UTM east/north) or geodetic Latitude/ Longitude. The latter may be either in DMS (dddmmss.ss) or decimal degrees (ddd.ddddddd) format .

If in DMS format then the values require 'N', 'S', 'E', 'W' appended to them to indicate their quadrant.

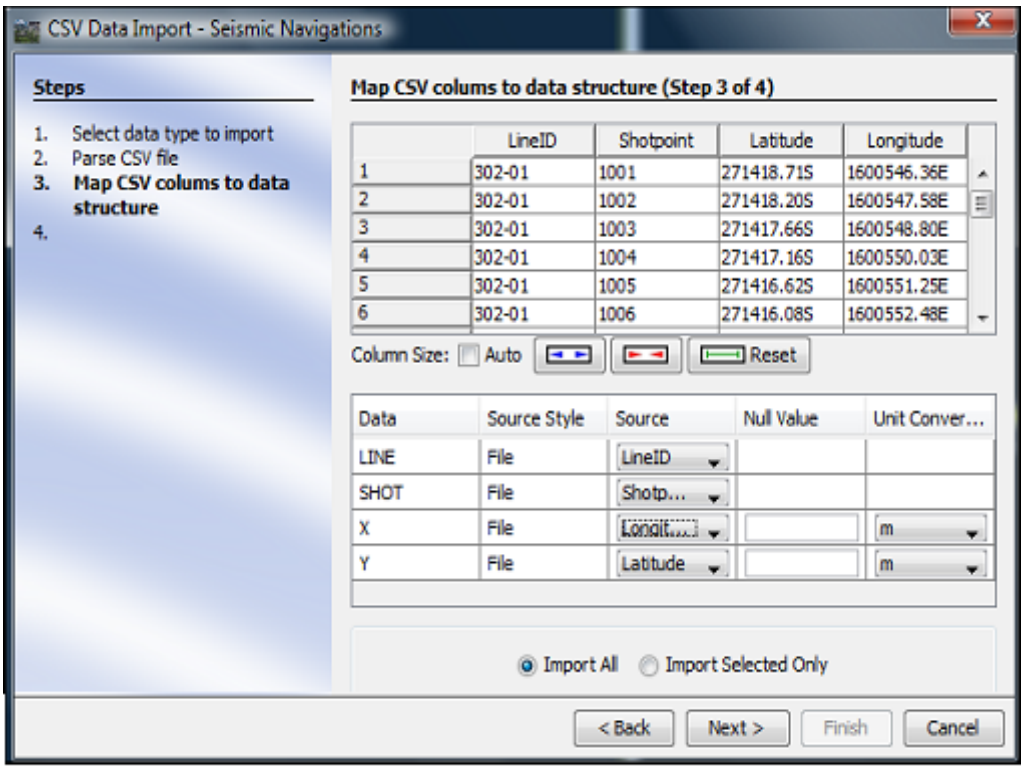
If in decimal format then the sign of the value indicates the quadrant.

Once the first navigation file has been loaded the file format and variable names are saved to a DDF (ie seismic_nav.ddfpb). The format window can then be populated by clicking on the "..." button in the dialog window and loading the DDF for subsequent navigation files in the same format.

6 Click **Next->** to move to next Page.

Wizard Step 3:

7 Map the fields to the correct Data names. If your data is Lat/Long then make sure you choose Longitude for X and Latitude for Y.


CSV Data Import - Seismic Navigations
Steps
1. Select data type to import
2. Parse CSV file
3. Map CSV colums to data structure
4.
Map CSV colums to data structure (Step 3 of 4)
LineID Shotpoint Latitude Longitude
1 302-01 1001 271418.71S 1600546.36E
2 302-01 1002 271418.20S 1600547.58E
3 302-01 1003 271417.66S 1600548.80E
4 302-01 1004 271417.16S 1600550.03E
5 302-01 1005 271416.62S 1600551.25E
6 302-01 1006 271416.08S 1600552.48E
Column Size: Auto Reset
Data Source Style Source Null Value Unit Conver...
LINE File LineID
SHOT File Shotp...
X File Longit...
Y File Latitude
m
m
Import All Import Selected Only
< Back Next > Finish Cancel

8 Click **Next->** to move to next Page.

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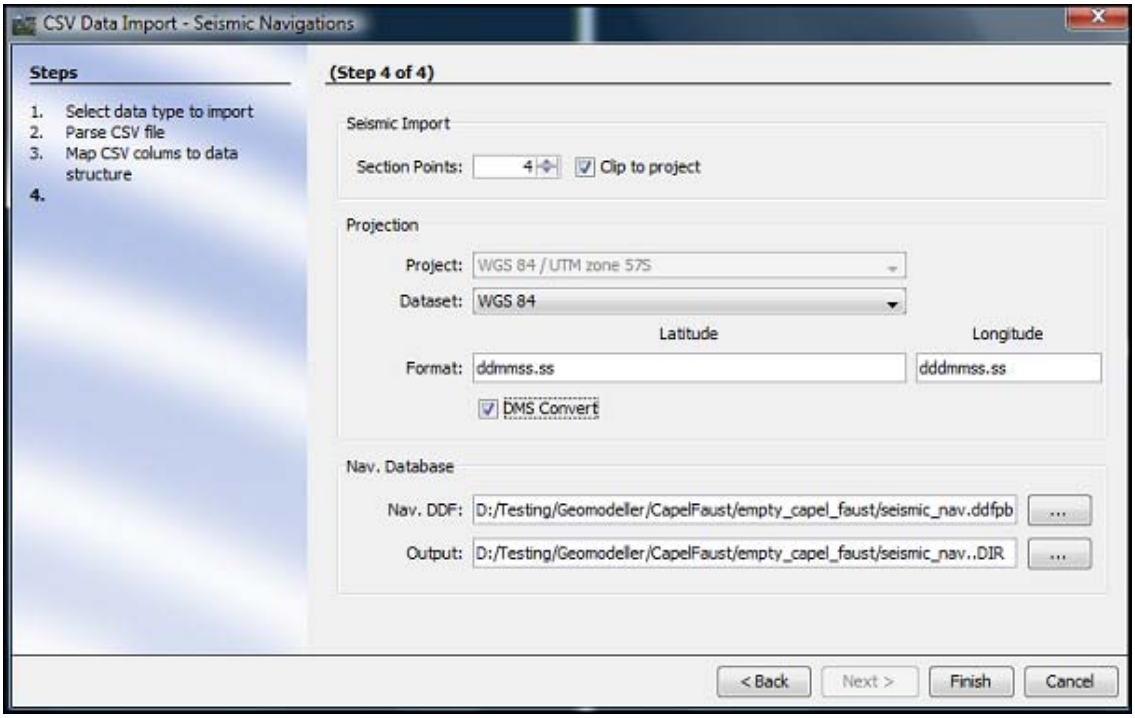

Wizard Step 4:

The items in this wizard dialog are described in the following table

Option	Description
Section Points	Number of points to use to define the GeoModeller section after thinning.
Clip to Project	When checked, points outside the project extents are ignored
Projection - Project:	The GeoModeller Datum/Projection
Projection - Dataset:	The imported coordinates Datum/Projection
Latitude Longitude - Format	The formats of the incoming Lat/Long coords - active when DMS convert is ON
DMS convert	When ON geodetic coordinates are converted on import to the GeoModeller project's Datum/ Projection. Note GeoModeller requires cartesian coordinates
Nav Database - Nav DDF	The name of the DDF file to save during the import stage
Nav Database - Nav DDF	Output file name for the Intrepid database containing the imported Nav data

9 Set the number of points to use for a section after thinning. The number of points required to accurately define the section will depend on the straightness of the incoming seismic line.

10 Set Datum/Projection of the incoming dataset ie WGS 84 if Geodetic (Lat/Long)

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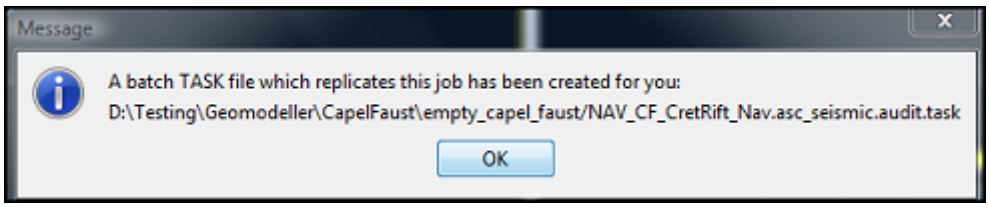
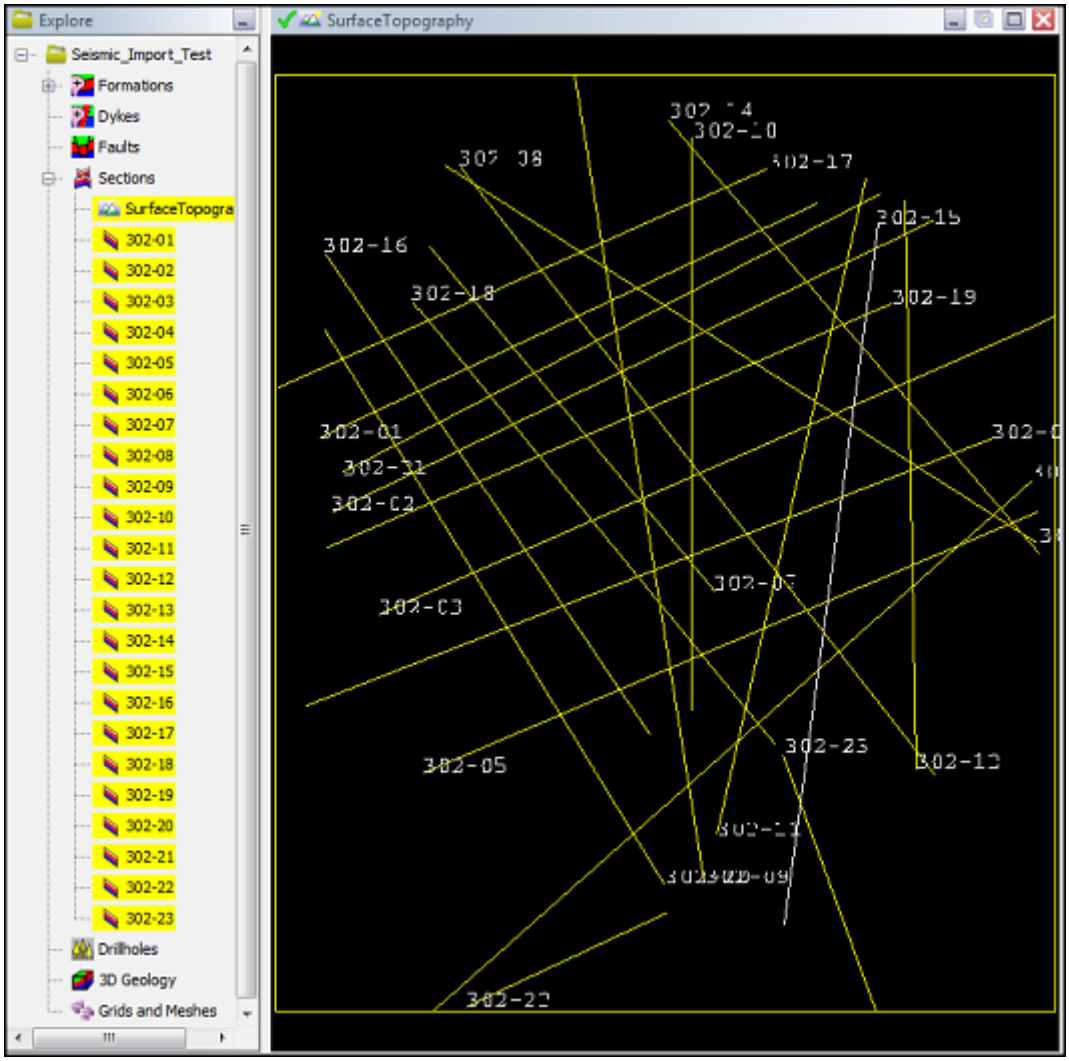
and choose DMS Convert to reproject to the GeoModeller coordinate system during import. Make sure the formats for Latitude and Longitude match the ascii data being imported ie (ddmmss.ss, dddmmss.ss).

11 Click **Finish->**

12 The import will proceed while displaying an oscillating progress bar. On completion the following dialog will display and the sections will be drawn on the Surface Topo section in the GeoModeller 2D viewer.


Message
A batch TASK file which replicates this job has been created for you:
D:\Testing\Geomodeller\CapelFaust\empty_capel_faust/NAV_CF_CretRift_Nav.asc_seismic.audit.task
OK

The saved task file is intended for use in batch mode to automate the import of a large number of navigation files to a prexisting GeoModeller project independent of the requirement to have GeoModeller running.



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Horizon Import

The horizon import creates a Geomodeller formation and series for each horizon in the input dataset. Interpreted horizon picks are imported into Geomodeller as 3D interface points. True dip is calculated from a regression plane fitted to all points within a user specified radius of seismic line intersections. Apparent dip can be imported as a separate step using the ASCII import wizard within Geomodeller.

In order to determine the 3D coordinates of a pick point, the navigation database files are required. These are generated when the navigation data is first imported using the **Navigation Import** option in GeoModeller or at another time via the Intrepid import tool. There can be any number of navigation data files or horizon files

Horizon Input Data

The horizon input file format is very similar to that used in the navigation step and both Navigation and Horizon data can be in the same file. It is a flat ASCII fixed-width file with the LINE-ID and SHOTPOINT columns, followed by N columns for the horizon pick depths, where N is the number of horizons.

As with the navigation data all picks for a line must be contained within the one file. In other words, data along a line may not be split across several files. However, there may be several input files each with different seismic lines.

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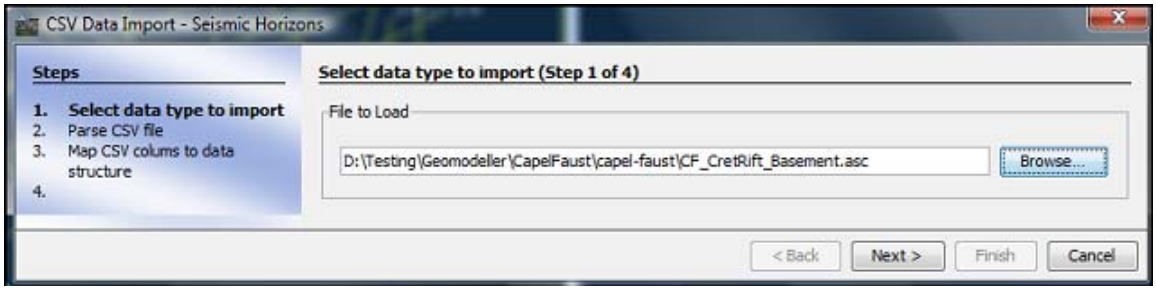
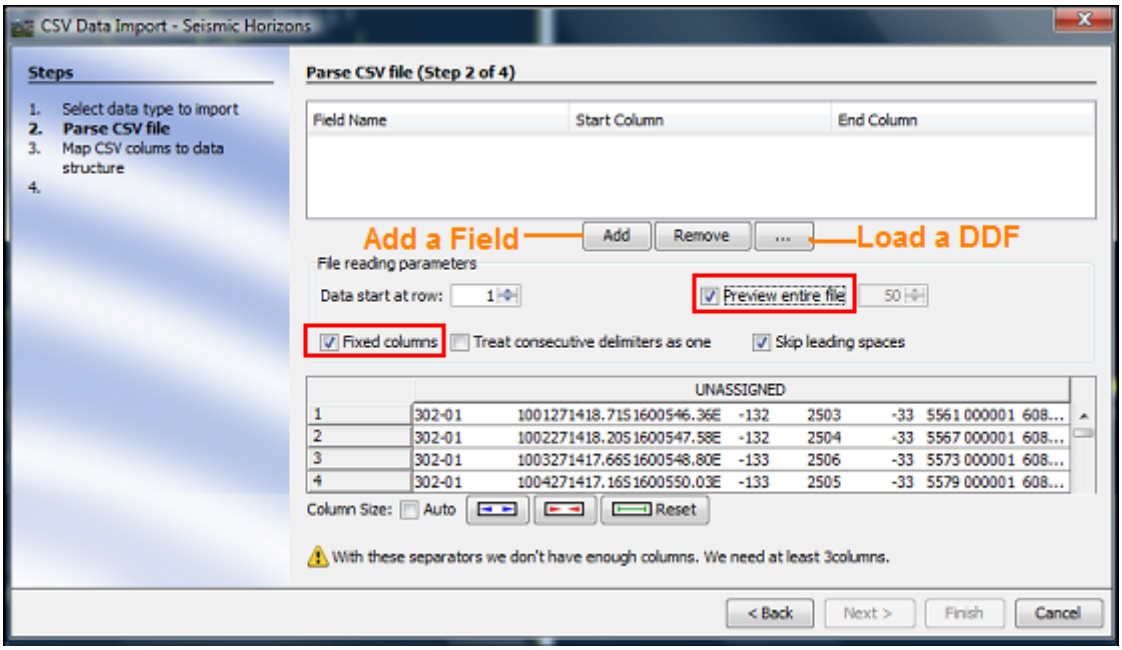
1 To commence the import of horizon pick data choose:

Import-> Seismic->Seismic Horizons option from the *3D Geomodeller* main menu and select the fixed format ascii horizon file to import. The GeoModeller project containing the previously imported Navigation data and the generated seismic line sections must be open.

Wizard Step 1:



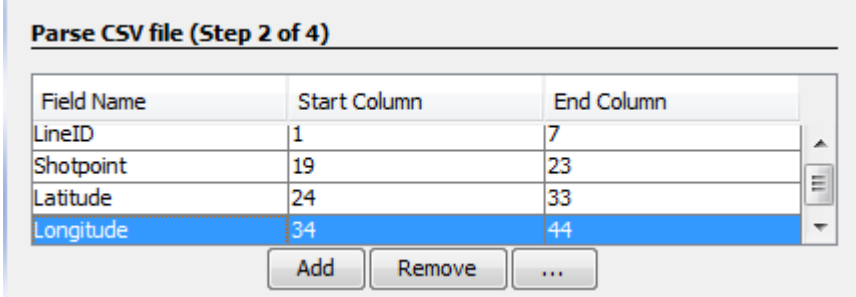
2 Click **Next->** to move to next Page.


CSV Data Import - Seismic Horizons
Steps
1. Select data type to import
2. Parse CSV file
3. Map CSV colums to data structure
4.
Parse CSV file (Step 2 of 4)
Field Name
Start Column
End Column
Add a Field
Add
Remove
...
Load a DDF
File reading parameters
Data start at row: 1
Preview entire file
50
Fixed columns
Treat consecutive delimiters as one
Skip leading spaces
UNASSIGNED
1 302-01 1001271418.715 1600546.36E -132 2503 -33 5561 000001 608...
2 302-01 1002271418.205 1600547.58E -132 2504 -33 5567 000001 608...
3 302-01 1003271417.665 1600548.80E -133 2506 -33 5573 000001 608...
4 302-01 1004271417.165 1600550.03E -133 2505 -33 5579 000001 608...
Column Size: Auto Reset
With these separators we don't have enough columns. We need at least 3columns.
< Back
Next >
Finish
Cancel

Wizard Step 2:

3 Set the file format to **Fixed Columns** and select **Preview entire file**

4 Click **Add** to add a field then enter the fixed format column positions for each variable. Use an editor to obtain the column positions before the import run. Do not attempt to edit the automatic column position for last field as this usually corrupts the previous field and turns the previous field rows red.



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The required fields for the horizon import are:

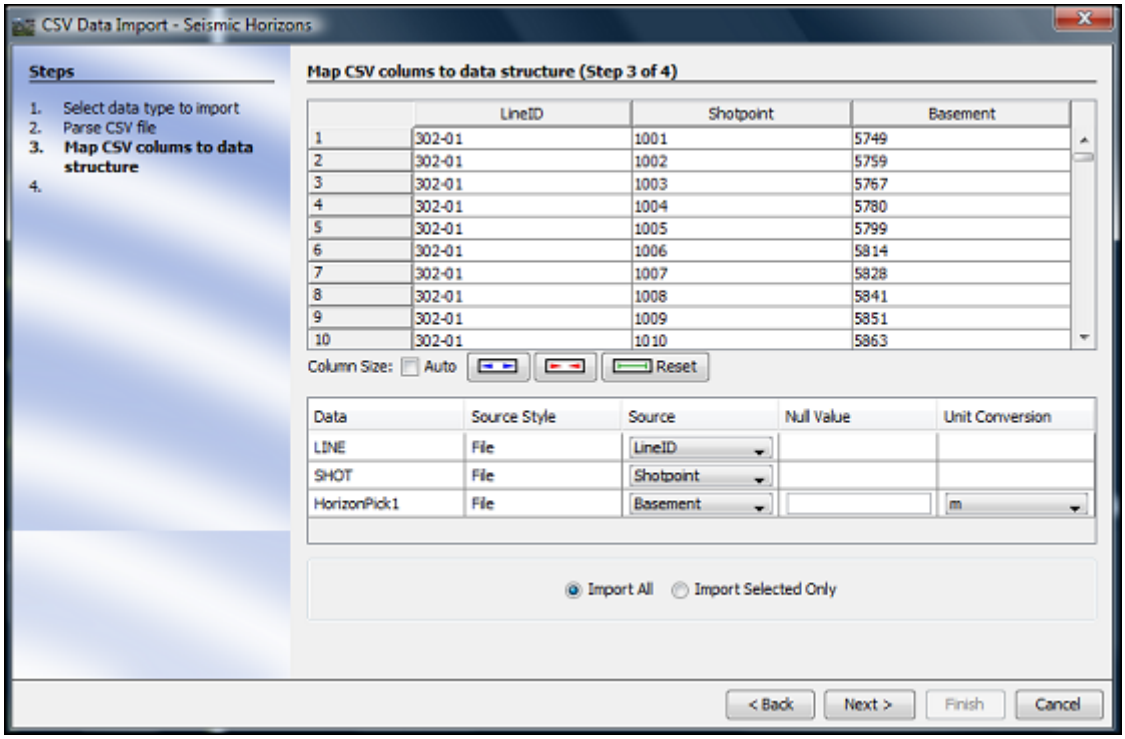
Field	Field Description	Data type
Line	The Seismic line identifier created in the GeoModeller project during Navigation import	alpha numeric
Shotpoint	Shotpoint number used to map coordinates to Formation picks (The lookup identifier with an identicaL match in the Navigation file)	numeric
Horizon1	The depth of the seismic pick for horizon1 (relative to project DTM elevation at that x,y location)	numeric
Horizon2	The elevation of the seismic pick for horizon1 (relative to project DTM elevation at that x,y location)	numeric
Horizon...	The elevation of the seismic pick for horizon (relative to project DTM elevation at that x,y location)... etc	numeric

While the number of horizons is arbitrary, there must be at least one in the input dataset.

5 Click **Next->** to move to next Page.

Wizard Step 3:

6 Map the fields to the correct Data names.


CSV Data Import - Seismic Horizons
Steps
1. Select data type to import
2. Parse CSV file
3. Map CSV colums to data structure
4.
Map CSV colums to data structure (Step 3 of 4)
LineID
Shotpoint
Basement
1 302-01 1001 5749
2 302-01 1002 5759
3 302-01 1003 5767
4 302-01 1004 5780
5 302-01 1005 5799
6 302-01 1006 5814
7 302-01 1007 5828
8 302-01 1008 5841
9 302-01 1009 5851
10 302-01 1010 5863
Column Size: Auto Reset
Data Source Style Source Null Value Unit Conversion
LINE File LineID
SHOT File Shotpoint
HorizonPick1 File Basement m
Import All Import Selected Only
< Back Next > Finish Cancel

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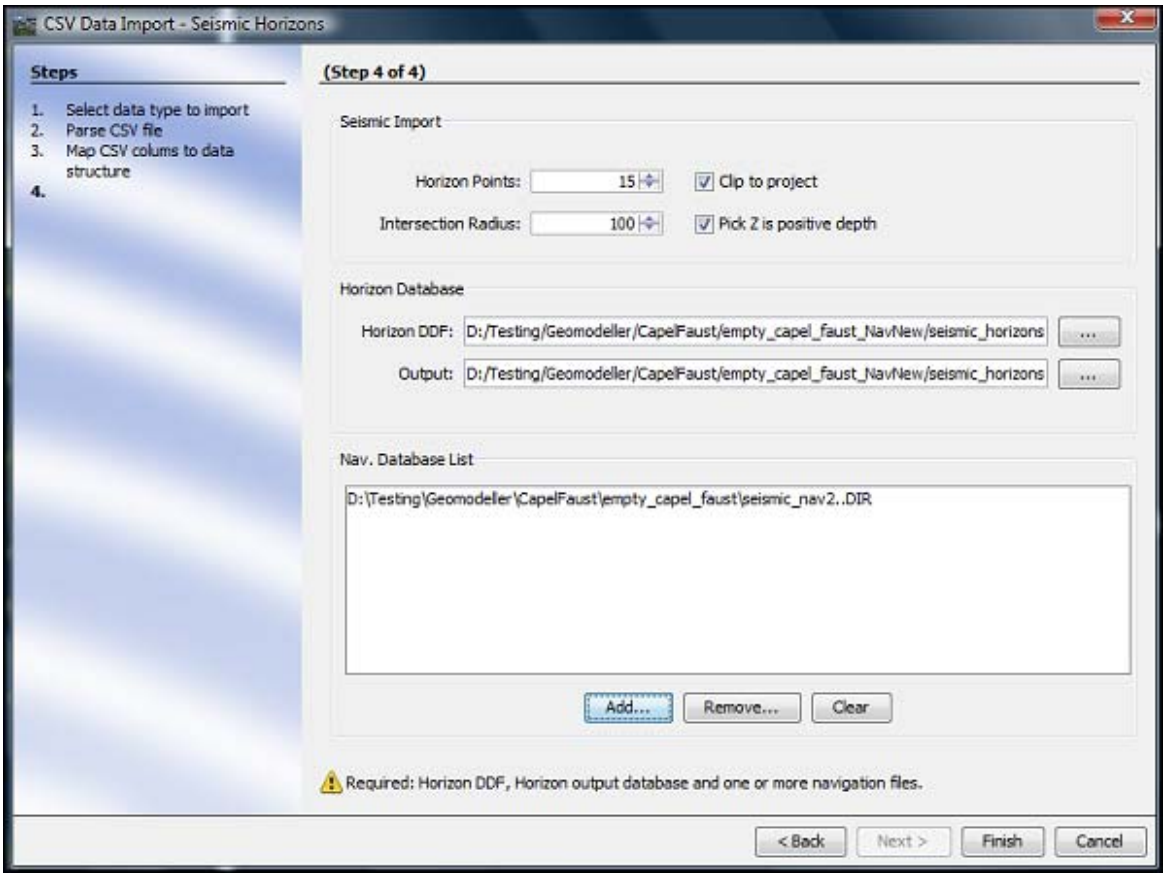
7 Click **Next->** to move to next Page.



Wizard Step 4:

The items in this wizard dialog are described in the following table. These options control how the Horizon picks are thinned, depths converted to elevations and the horizon true dips and strikes (orientations) are calculated at section intersections.

Option	Description
Intersection Radius	Radius around each line intersection when calculating the true-dip
Max. Line Points	Maximum number of points per line to import.
Clip to Project	Remove any picks outside the GeoModeller project x,y,z limits
Pick Z is positive depth	If selected this option converts positive depths below surface to GeoModeller elevations
Horizon DDF	Pathname of the saved DDF for the horizon data file. Created or loaded during Step 2.
Horizon Database	Pathname of the saved Intrepid horizon output database
Nav Database List	A list of navigation databases (full paths) used to lookup coordinates of the Horizon picks, (Line, Shotpoint) is used for the lookup.

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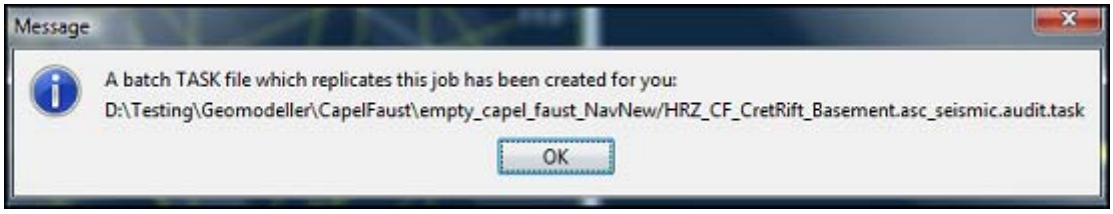
True Dip

Geomodeller requires both contact data and orientation data in order to compute a model. With regards to the seismic import tool this is in the form of 3D interface points and 3D orientation data. The 3D interface data are brought in via the thinned horizon picks while the 3D orientation data relate to the true-dip calculation at seismic lin intersections.

A true-dip orientation is calculated for each horizon that has points within a user specified radius around each seismic line intersection. An orthogonal regression plane is fitted to the points and the dip and dip-direction are then calculated from the plane. The true-dip is calculated using the raw input data not the thinned data that Geomodeller uses as 3D interface points.

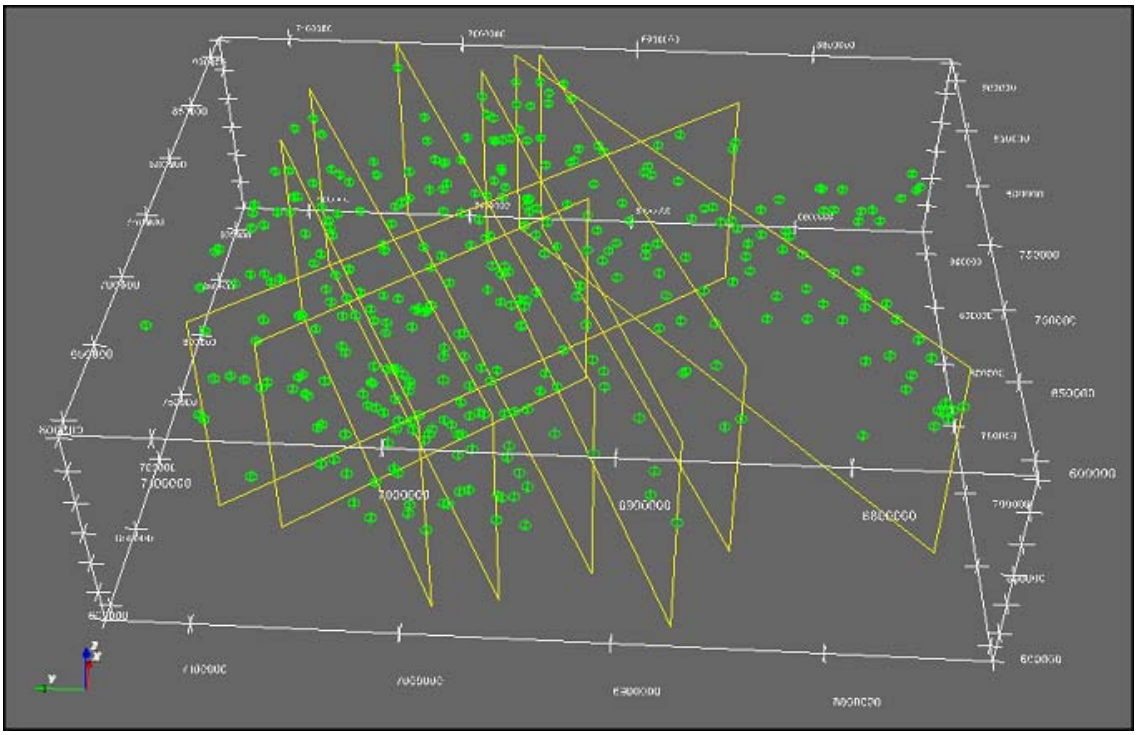
8 Click **Finish->**

9 The import will proceed while displaying an oscillating progress bar. On completion the following dialog will display. At this point the Formations, horizon picks and orientation data will have been loaded into the GeoModeller project.


Message
A batch TASK file which replicates this job has been created for you:
D:\Testing\Geomodeller\CapelFaust\empty_capel_faust_NavNew/HRZ_CF_CretRift_Basement.asc_seismic.audit.task
OK

The saved task file is intended for use in batch mode to automate the import of a large number of navigation and horizon files to a prexisting GeoModeller project independent of the requirement to have GeoModeller running.

10 At this point the use can visualise the imported data using the GeoModeller 3D viewer as shown below.



3D view of Seismic picks for the Basement horizon

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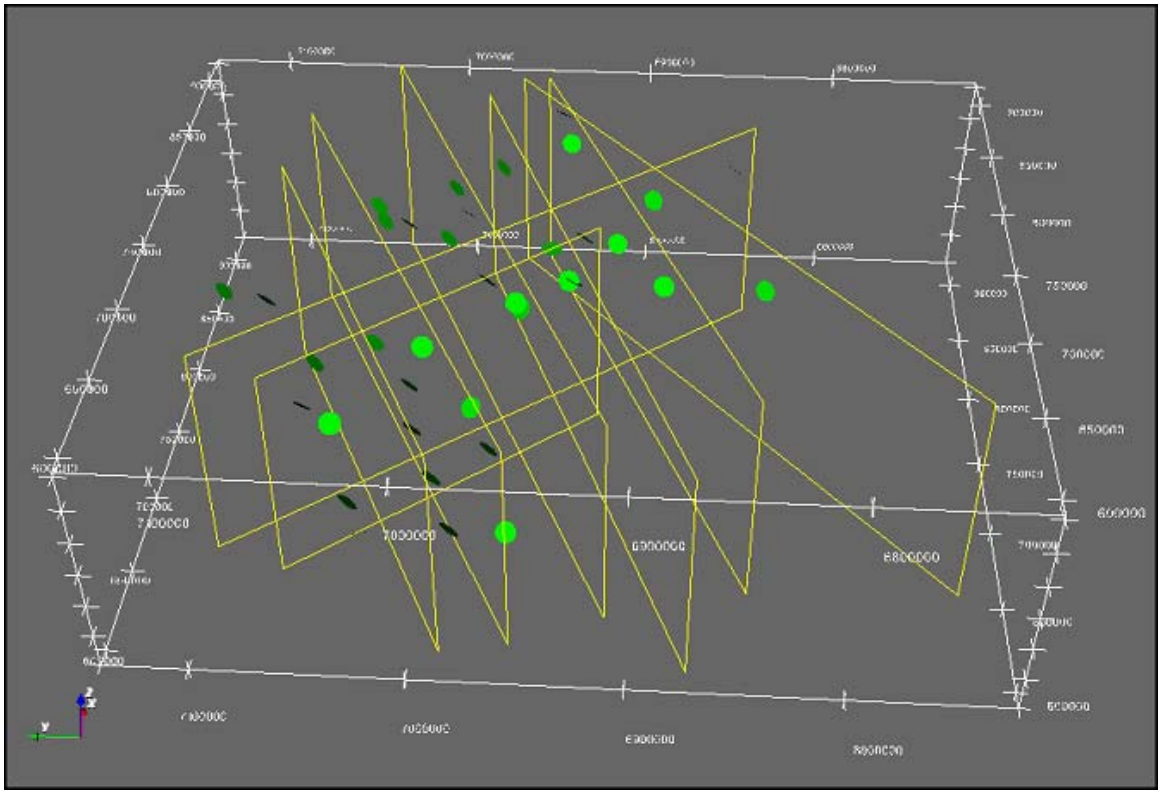

3D view of horizon orientations (Dip/Dip Direction) computed at section intersections for the Basement horizon.

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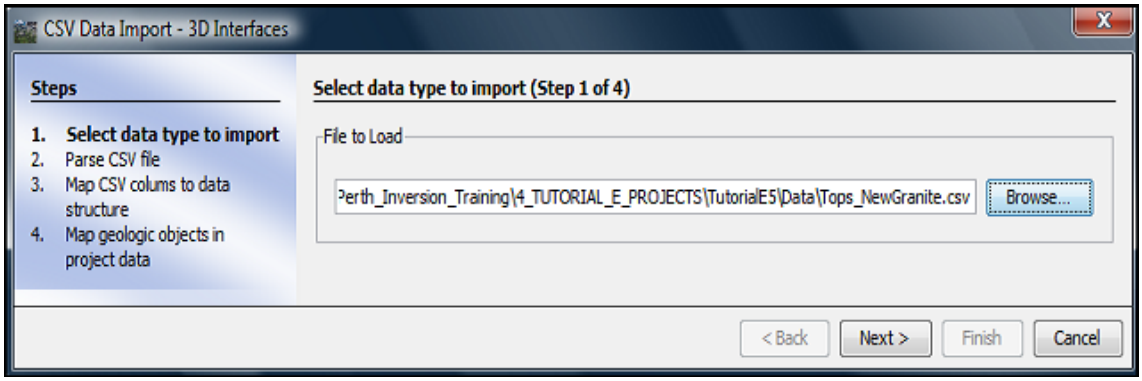
CSV data import wizard

Parent topic: Import menu and dialog boxes

Use the **CSV data import** wizard to import data in ASCII columns equivalent to the comma separated value (CSV) format.

- Step1 Browse to datafile to import



Import steps

The wizard steps you through the import, enabling you to:

1. Parse import files—see CSV data import wizard—Parse import file
2. Map import fields to project fields—see CSV data import wizard—Map import fields to project fields
3. *(If you are projecting 3D data onto sections)* Select sections on which to project data—see CSV data import wizard—Select sections for projecting data
4. Create and select objects whose associated data you want to import—see CSV data import wizard—Create and select objects to receive data
5. View a report of the import—see CSV data import wizard—Report

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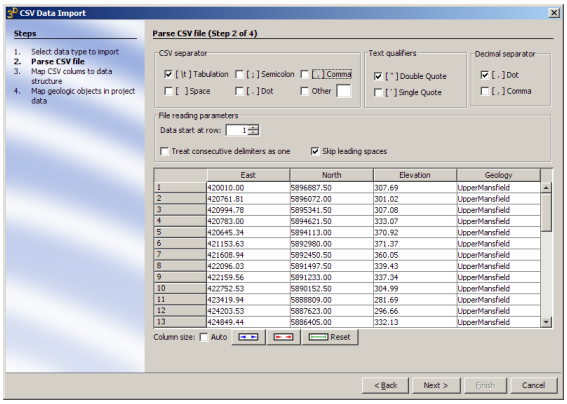
CSV data import wizard—Parse import file

Parent topic: CSV data import wizard

Use this page to specify the field and text delimiters and decimal separator in the import data and the spaces and records to skip at the beginning of lines and of the file. 3D GeoModeller the resulting interpretation of the data in a table.



Controls in this wizard page

Control	Purpose
CSV Separator	Character separating the fields in the import file
Text qualifiers	Character denoting that a field contains text. Data begins and ends with the selected character
Decimal separator	Character used as the decimal separator, separating the whole number part from the fractional part of a number
Data start at row	Skip all import file text lines or rows at the beginning of the import file until the one you specify here, which is the first line or row of data. For example, if you specify 4, 3D GeoModeller ignores the first three lines (rows) of the import daa file.
Treat consecutive delimiters as one	When checked, if 3D GeoModeller encounters consecutive field delimiter characters (with no other characters between them) it treats them as a single field delimiter.
Skip leading spaces	When checked, 3D GeoModeller ignores all spaces at the start of lines (rows) in the import file
Data table	Based on the settings you have made, 3D GeoModeller in this table how it will parse the data.
Column width controls	See Column width controls

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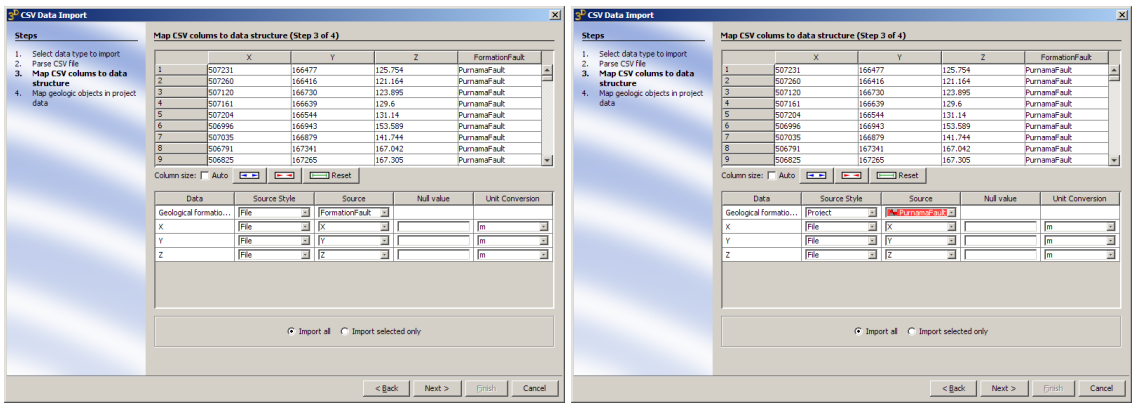
CSV data import wizard—Map import fields to project fields

Parent topic: CSV data import wizard

Use this page to map the fields in the import data to the fields and object types in your 3D GeoModeller project.



Controls in this wizard page

Control	Purpose
Data table	Table of fields and records that 3D GeoModeller has obtained from the import data file based on your parsing specifications (see CSV data import wizard—Parse import file)
Column width controls	See Column width controls
Field mapping table	
Data	Fields that 3D GeoModeller requires
Source style	How you intend to supply the data for each 3D GeoModeller field and object type **File**: Import the data from the import data file **Project**: Select an object from the project and associate all import data with it **User**: Enter the data yourself
Source	If you have selected: **File**: Import data field containing the required data **Project**: Object from the project with which 3D GeoModeller will associate all import data **User**: Data value that you enter
Null value	Value in the import data that represents ***Null***
Unit conversion	Distance units of the import data. 3D GeoModeller converts the import data to metres

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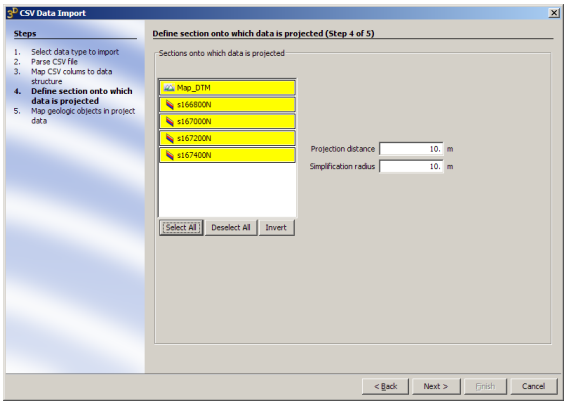
CSV data import wizard—Select sections for projecting data

Parent topic: CSV data import wizard

If you are projecting the 3D data onto sections after import and converting it to 2D data associated with a section, use this page to select the sections onto which you want to project the data and the sensitivity parameters that you require.



Controls in this wizard page

Control	Purpose
Sections onto which data projected	Sections available onto which you can project imported data. See How to select items from a list.
Maximum distance of projection	Data needs to be within this distance of the section for 3D GeoModellerto project it onto the section
Simplification radius	If there are several points within the same radius, 3D GeoModelleronly projects one point to represent them.

CSV data import wizard—Create and select objects to receive data

Parent topic: CSV data import wizard

After you have mapped the import data fields with the corresponding fields and object types in the 3D GeoModeller project, you can match each instance of an import data object with an object in the 3D GeoModeller project. If no matching object exists in the project, you can create it in the import operation.

For example, for matching formations and faults, 3D GeoModeller displays a list of all import file formations and faults and tries to match it with its own existing formations and faults, displaying a list. For each import formation or fault, you can:

- Import the data to a corresponding project formation or fault in the project OR
- Create a new formation or fault in the project.

In this section:

- Matching objects
- Creating new objects during import
- Columns in this wizard page
- Global and individual match-up actions

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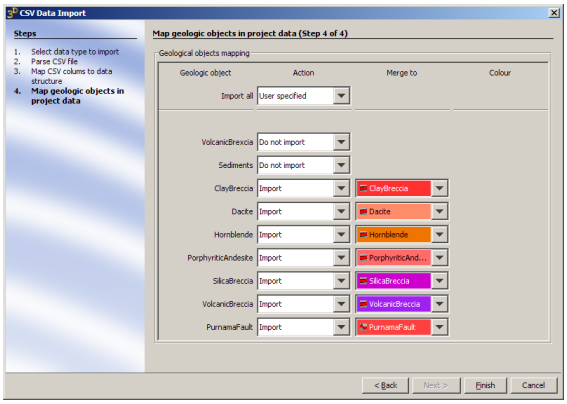
Parent topic: CSV data import wizard—Create and select objects to receive data

Matching objects

If 3D GeoModeller can match import formations and faults with project ones, it displays a match-up list. In the following illustration, most data matched up with the existing formations and faults, but some data had formation or fault name with a typographic error and 3D GeoModeller failed to match some data with the existing objects. One of the formation names was different in the data, **`Sediments`** instead of **`Sediment`**, and some of the data belonging to the formation **`VolcanicBreccia`** had **`VolcanicBrexcia`**.



Here is a segment of the import data

```
X,Y,Z,FormationFault
506411,167799,52.6939,Sediments
506316,167799,52.6939,Sediments
507719,166901,96.5455,VolcanicBrexcia
507573,166768,143.465,VolcanicBrexcia
507616,166790,104.999,VolcanicBrexcia
507666,166851,93.1114,VolcanicBreccia
507300,166491,145.266,VolcanicBreccia
507351,166560,196.822,VolcanicBreccia
507407,166647,211.092,VolcanicBreccia
```

In this example, to correct this situation, for each unmatched object, select **Merge to formation** and then, in the **Merge to column**, select the required existing project formation.

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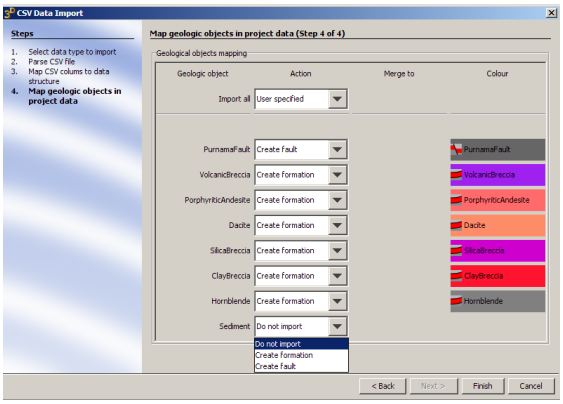
Creating new objects during import

Parent topic: CSV data import wizard—Create and select objects to receive data

In the illustration below, the 3D GeoModeller project had defined sections but no formations or faults. We decided to create the formations and faults and assign them colours at the time of import.



Columns in this wizard page

Parent topic: CSV data import wizard—Create and select objects to receive data

The following table explains the four columns in this wizard page.

Control	Purpose
Geological object	Object named in the import file
Action	Action to perform on the data associated with the object in the import file. See Global and individual match-up actions
Merge to	Existing project object to which 3D GeoModeller will import the data. This appears if both: • Project objects exist AND • You select **Import** or **Merge to formation** or **Merge to Fault** *(For individual objects)* If an individual import object exactly matches a project object and you select **Import**, you are not able to select a different target project object. If you want to select a different project object, select one of the **Merge** actions See Global and individual match-up actions
Colour	New object to create during import. This appears when you select **Create formation** or **Create fault**. See Global and individual match-up actions. *(For individual objects)* Its name matches the import file object. To assign a colour to a new object, click it. See Colour Palette dialog box.

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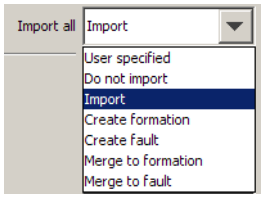
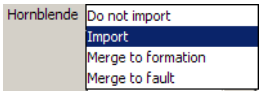
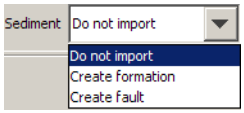
Parent topic: CSV data import wizard—Create and select objects to receive data

Global and individual match-up actions

You can specify a global action for all objects or individual actions for each individual object. For global action, use the **Import all** drop-down list. For individual action, set it to **User specified** and select an individual actions for each object.







See the following table for an explanation of the possible actions:

Action	Import all	Individual
User specified	Use individual selections	not applicable
Do not import	Do not import any data	Do not import data for this object
Import	Import all data to a single existing project object	Import data for this existing project object from the matching object in the import file
Create formation	Create a new project formation and import all data to it	Create a new project formation with a name the same as the formation in the import file and import the corresponding data to it
Create fault	Create a new project fault and import all data to it	Create a new project fault with a name the same as the fault in the import file and import the corresponding data to it
Merge to formation	Import all data to a single existing project formation	Import the data for this object in the import file to an existing project formation of a different name
Merge to fault	Import all data to a single existing project fault	Import the data for this object in the import file to an existing project fault of a different name

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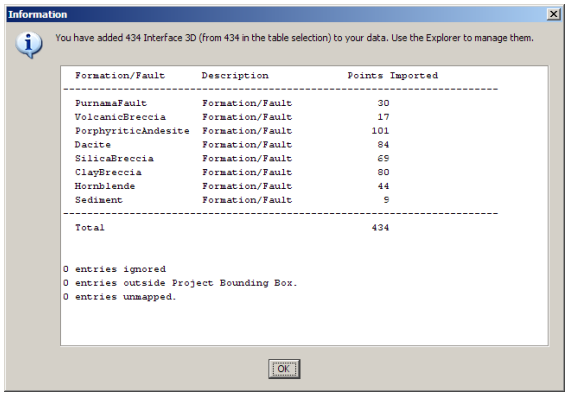
CSV data import wizard—Report

Parent topic: CSV data import wizard

After the import, 3D GeoModeller displays a report of the operation



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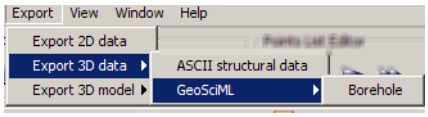
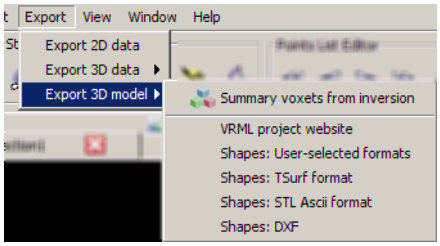
Export menu and dialog boxes

Parent topic: 3D GeoModeller main menus

Use the **Export** menu items to export project data in the format of your choice.





See the following table for an overview of the **Export** menu

Control	Purpose
Export 2D data	See Export 2D Data from— dialog box
Export 3D data	
ASCII structural data	Export interface and orientation data in ASCII BRGM format
GeoSciML: Drillhole	Export drillholes in GeoSciML-compliant XML
Export 3D model	
Summary voxets from inversion	Inversion summary voxet in ASCII format
VRML project website	Shapes and 3D data in VRML 2
Export 3D Shapes	
Shapes: BREP	Open Cascade format
Shapes: TSurf format	GoCAD format for triangles
Shapes: STL ASCII format	Standard 3D vector format
Shapes: DXF	AutoCAD 3D vector format
Shapes: IGES	International open standard 3D vector format
Shapes: STEP	International open standard 3D vector format (more recent than IGES)

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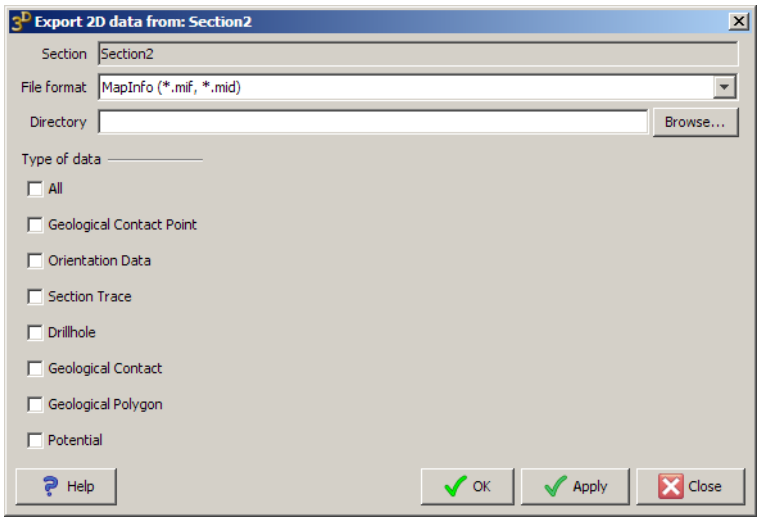
Export 2D Data from— dialog box

Parent topic: Export menu and dialog boxes

Use this dialog box to export your choice of data associated with a section. You can specify export format, location and name of the export file and the types of data to export.



Controls in this dialog box

Control	Purpose
Section	Section from which to export data
File format	Export file format. You can export in MIF MID or ASCII BRGM
Browse, File name	Export filename and path
Type of data	Types of data for export. Check the boxes as required.

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Exporting 3D models

Parent topic: Export menu and dialog boxes

You can export the model as:

- Summary voxets (from inversion)
- Shapes in the following 3D vector formats
  - BREP
  - VRML 2
  - TSurf
  - STL ASCII
  - DXF
  - IGES
  - STEP
  - VTKPolyData
  - VULCAN

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View menu and dialog boxes

Parent topic: 3D GeoModeller main menus

Menu, submenus and related menus

- View menu, cascades, shortcut menus and toolbars

Dialog boxes related to View menu, submenu and related menu options

- 2D Viewer Presentation dialog box
- Section Properties dialog box
- Section Display Parameters dialog box
- Image Manager dialog box
- Edit and Align Image dialog box
- 3D Viewer Presentation dialog box
- 3D Viewer Presentation dialog box
- Load Surface Mesh
- Show Orientation Data in 3D Viewer dialog box
- Show Drillholes in 3D Viewer dialog box
- Appearance of Drillholes dialog box
- Show Interface Data in 3D Viewer dialog box
- Vertical Exaggeration dialog box
- Appearance of objects dialog box family
- Colour Palette dialog box
- Column width controls
- Point Acquisition Parameters dialog box
- Points List Visualisation dialog box

View menu, cascades, shortcut menus and toolbars

Parent topic: View menu and dialog boxes

The **View** menu has a number of cascade menus, repeated groups of menu options and options that duplicate the toolbars:

- View menu
- 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus
  - Data shortcut submenu
    - Delete Data shortcut sub menu
- 3D Viewer sub and shortcut menu
- 3D Controls sub menu and 3D Viewer toolbar
- Submenus common to various menus
  - Vertical exaggeration submenu and toolbar
  - Pan and zoom controls

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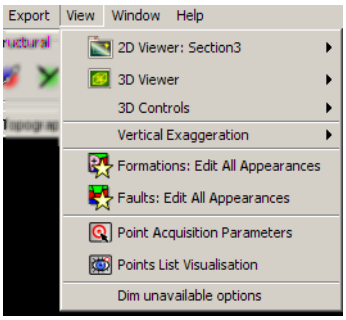
View menu

Parent topic: View menu, cascades, shortcut menus and toolbars

Use the **View** menu items to specify the choice and the appearance of the data that you want to see in the 3D GeoModeller window, including both the **2D Viewer** and the **3D Viewer**.



See the following table for an overview of the **View** menu

Elements	Purpose
2D Viewer	See 2D Viewer sub menu and main shortcut menu, Project Explorer Section menus
3D Viewer	See 3D Viewer sub and shortcut menu
3D Controls	See 3D Controls sub menu and 3D Viewer toolbar
Vertical Exaggeration	See Vertical exaggeration submenu and toolbar
Formations: edit all appearances	See Appearance of objects dialog box family
Faults: edit all appearances	See Appearance of objects dialog box family
Point acquisition parameters	See Point Acquisition Parameters dialog box
Points list visualisation	See Points List Visualisation dialog box
Dim unavailable options	When checked, 3D GeoModeller dims menu options that are unavailable in the current context. When not checked, 3D GeoModeller displays warning messages when you select options that are unavailable in the current context (default setting)

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2D Viewer sub menu and main shortcut menu, Project Explorer Section menus

Parent topic: **View menu, cascades, shortcut menus and toolbars**

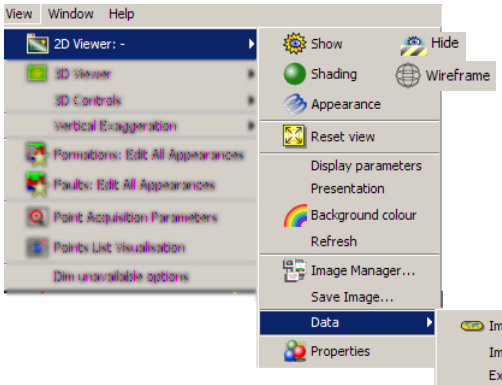
All of these menus contain similar options, so we describe them in this combined section.

Within the 2D Viewer menu:

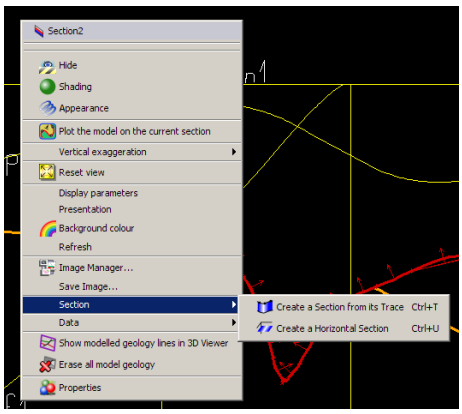
- Data shortcut submenu
  - Delete Data shortcut sub menu

For an overview of the specific **2D Viewer** shortcut menus for different objects, see 2D Viewer shortcut menus

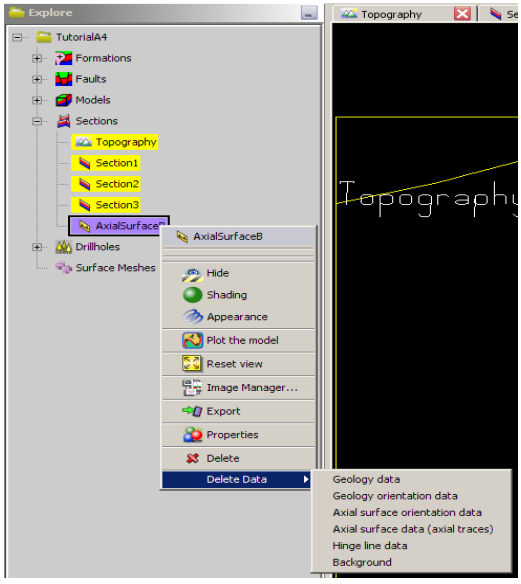
Main View menu > 2D Viewer



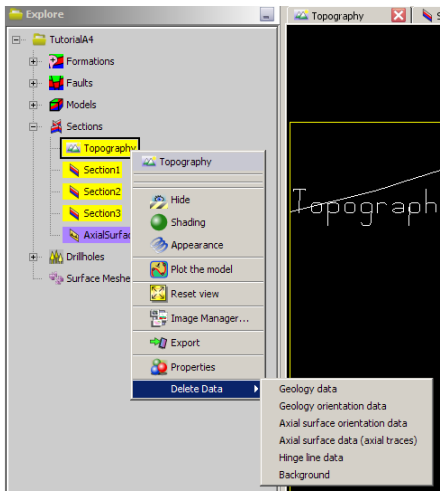
2D Viewer main shortcut menu



Project Explorer Section shortcut menu



Project Explorer Topography shortcut menu



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See the following table for an overview of the **2D Viewer** submenu and shortcut menu and the **Project Explorer** individual **Section** and **Topography** shortcut menus

Element	Description
2D viewer	
Show, Hide, Shading, Wireframe, Appearance	See Common shortcut menu options.
Plot the model (on the current section)	Plot the model on the currently selected section according to the current model settings (See Plot the Model Settings dialog box)
Reset View	Resets 3D GeoModeller window to the default layout. See 3D GeoModeller workspace
Display parameters	(Not in Project Explorer) See Section Display Parameters dialog box
Presentation	(Not in Project Explorer) See 2D Viewer Presentation dialog box
Background colour	(Not in Project Explorer) See Colour Palette dialog box
Refresh	(Not in Project Explorer)
Image Manager	See Image Manager dialog box
Save image	(Not in Project Explorer)
Section > Create a Sector from its Trace	(Not in Project Explorer) See Create a Section from its Trace dialog box
Section > Create a Horizontal Sector	(Not in Project Explorer) See Create a Horizontal Section dialog box
Data	(Not in Project Explorer) See Data shortcut submenu.
Show modelled geology lines in 3D Viewer	(not for **Topography** or in main **View** menu)
Erase all model geology	(not for **Topography** or in main **View** menu)
Export	(Project Explorer only) See Data shortcut submenu
Properties	See Section Properties dialog box
Delete Data	(Project Explorer only) See Data shortcut submenu.

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Data shortcut submenu

Parent topic: View menu, cascades, shortcut menus and toolbars

Use this menu to import data onto the section and delete data from it.

Option	Description
Import GIS and other binary located data	See Points List Editor (floated)
Import BRGM data	See Import 2D Geology to Section Submenu Options
Export 2D data	See Export 2D Data from— dialog box
Delete	See Delete Data shortcut sub menu.

Delete Data shortcut sub menu

Parent topic: View menu, cascades, shortcut menus and toolbars

Use items from this submenu to delete classes of data from the section.

Option	Description
Geology data	Delete all contact data from the selected section
Geology orientation data	Delete all orientation data from the selected section
Axial surface orientation data	Delete all axial surface orientation data from the selected section
Hinge line data	Delete all hinge line data from the selected section

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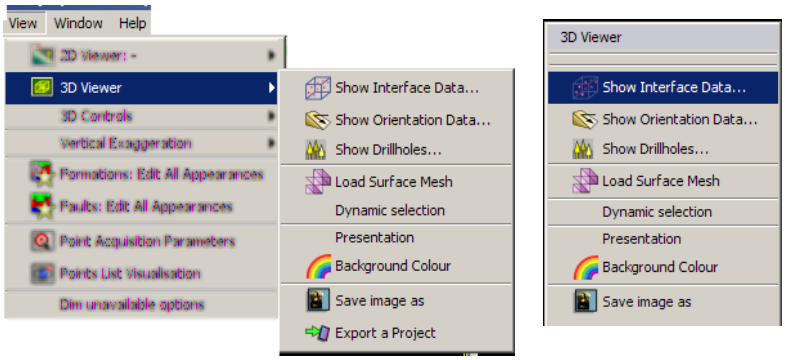
3D Viewer sub and shortcut menu

Parent topic: View menu, cascades, shortcut menus and toolbars

Use items from this menu to control the display in the **3D Viewer** and to export images or the whole project



See the following table for an overview of the **3D Viewer** sub menu and shortcut menu

Elements	Purpose
3D viewer	See 3D Viewer Presentation dialog box
Show interface data	See Show Interface Data in 3D Viewer dialog box
Show orientation data	See Show Orientation Data in 3D Viewer dialog box
Show drillholes	See Show Drillholes in 3D Viewer dialog box
Load surface mesh	See Load Surface Mesh
Dynamic selection	When you select this option, 3D GeoModeller selects elements in the **3D Viewer** when you point to them.
Presentation	3D Viewer Presentation dialog box
Background colour	See Colour Palette dialog box
Save image as	Save the current view as an image file in `.gif` or `.jpg` format

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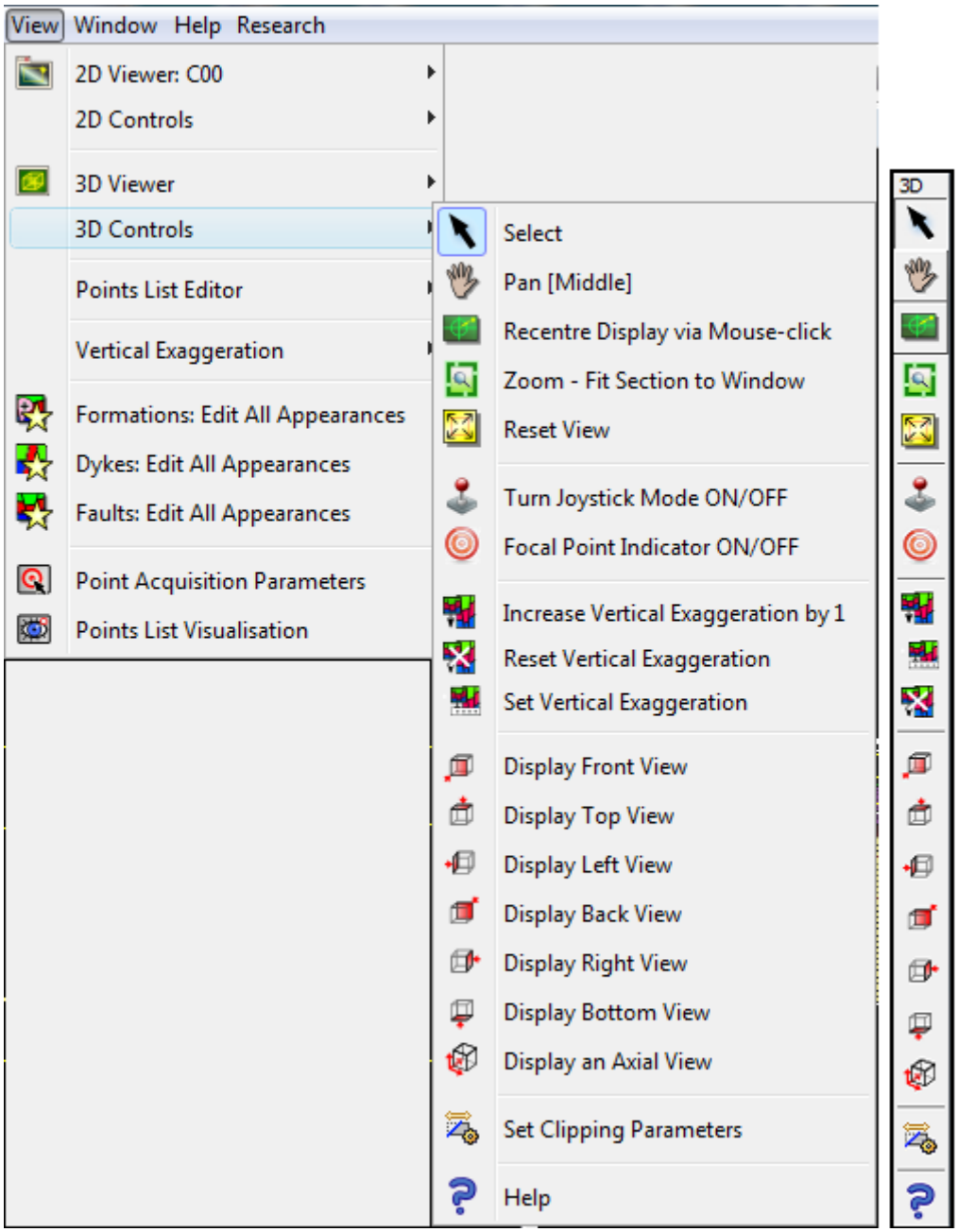
3D Controls sub menu and 3D Viewer toolbar

Parent topic: View menu, cascades, shortcut menus and toolbars

Use these menu items or toolbar buttons to control the **3D Viewer** display.



See the following table for an overview of the **3D Controls** submenu and shortcut menu

Element	Description	Icon
Pan, Zoom, Recentre, Rotate, Reset	See Pan and zoom controls	
Joystick and Focal Point	See Joystick and Focal point controls	
Vertical Exaggeration	See Vertical exaggeration submenu and toolbar	

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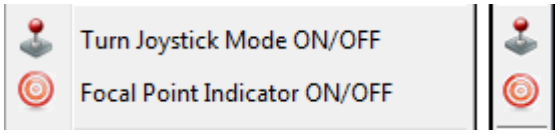
Element	Description	Icon
Preset views of project in 3D Viewer		
Display front view	Front face	
Display top view	Top face	
Display left view	Left face	
Display back view	Back face	
Display right view	Right face	
Display bottom view	Bottom face	
Display an axial view	Isometric view	
3D Clipping Controls		
Set Clipping Parameters	Bring up the Control dialog for 3D clipping. See 3D Viewer	

Joystick and Focal point controls

See the following table for an overview of the **Joystick and Focal point** menu and tools



Elements	Purpose	Icon
Joystick Mode ON/OFF	Turn ON/OFF Joystick Mode	
Focal point indicator ON/OFF	Turn ON/OFF the Focal point indicator when in Joystick mode.	

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Vertical exaggeration submenu and toolbar

Parent topic: View menu, cascades, shortcut menus and toolbars

Use items from this submenu to control the vertical exaggeration displayed in the **2D Viewer** or **3D Viewer**.

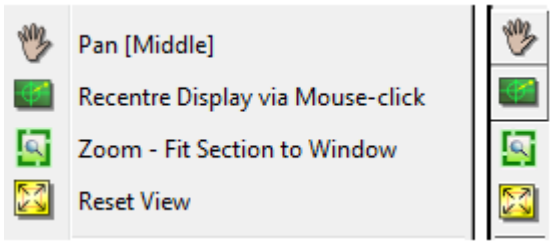
Se the following table for an overview of the **Vertical Exaggeration** menu and tools

Elements	Purpose	Icon
Increase vertical exaggeration by 1	Increase the vertical exaggeration factor by 1. See Vertical exaggeration	
Set vertical exaggeration	See Vertical Exaggeration dialog box.	
Reset vertical exaggeration	Reset the vertical exaggeration factor to 1. See Vertical exaggeration	

Pan and zoom controls

Parent topic: View menu, cascades, shortcut menus and toolbars

Use the 3D pan and zoom controls in the menu and toolbar to pan, zoom and rotate the display in the **3D Viewer**.



See the following table for an overview of the **3D Controls** submenu and shortcut menu

Element	Description	Icon	Mouse
Pan	Drag in the required direction using left mouse button		MIDDLE MOUSE
Recentre display via mouse click	(Not available in **2D Viewer**)		LEFT CLICK MOUSE
Zoom—fit selection to window	(Not available in **2D Viewer**) Fit (map or section) to current window size.		
Reset view	Reset viewer window to include full extent of its contents		

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3D Viewer Keyboard Shortcuts and Mouse Operations

Table 1: Keyboard Shortcuts

Key	Action	Description
t	Toggle to Trackball mode	
j	Toggle to Joystick mode	
r	Reset view	Zoom to full extents
x	Select graphic item under cursor	Hover cursor over graphic item and hit keyboard 'x'
f	Set Focal point	Focal point is active in Joystick mode only

Table 2: Mouse Operations

Mode	Mouse Button	Event	Action
Trackball	Left	Drag	Rotates model in the drag direction
Trackball	Middle	Drag	Pans model in the drag direction
Joystick	Left	Drag	Rotates camera around Focal point in direction of cursor movement at a speed relative to the distance from Focal point projected onto viewport
Joystick	Middle	Drag	Pans model in the direction of cursor movement at a speed relative to the distance from Focal point projected onto viewport.
Either	Left	Double Click	Selects the first object found under the cursor. All other objects are set partially transparent. If no object is found under the cursor location the background is selected. Deselect object by repeating action outside the 3D Viewer frame
Either	Right	Click	Popup context sensitive sub-menu depending on the object currently selected or whether no object is selected.
Either	Left	Click	No Action

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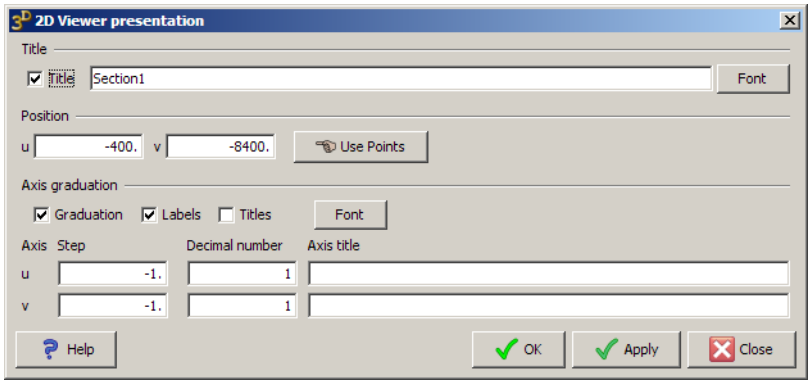
2D Viewer Presentation dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to specify the publishing annotations for a section, including title, position of title and axis properties.



Controls in this dialog box

Control	Purpose
Title	When checked, specified title is displayed
Position	Position of title. Enter the desired coordinates or choose **Use Points** to place the title according to the contents of the **Points List**
Axis graduation	When checked, axis tick marks are displayed
Axis step	Axis tick interval
Decimal number	Number of decimal places in axis tick labels
Axis title	Axis title

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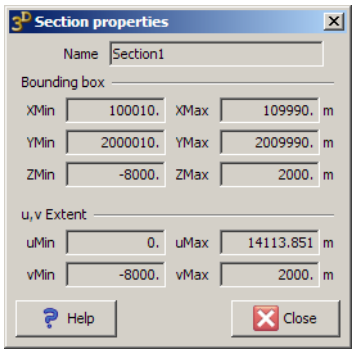
Section Properties dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to view the properties of a section.



Controls in this dialog box

Control	Purpose
Name	Name of section
Bounding box	Section extents in 3D real world coordinates
u,v extensions	Section extents in 2D local u, v coordinates

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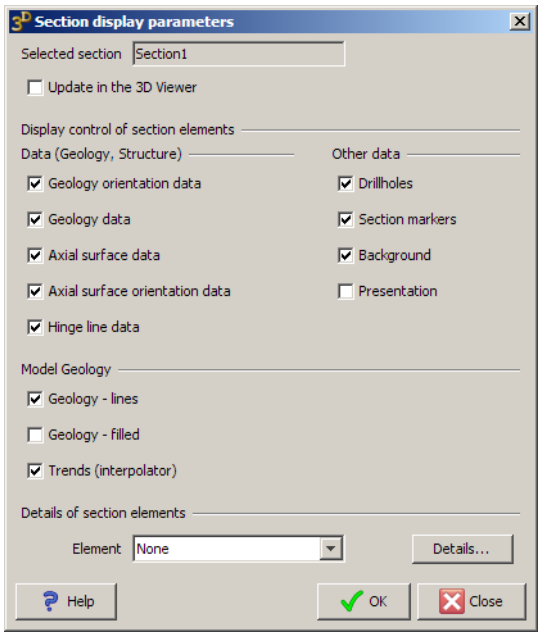
Section Display Parameters dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to specify how you want a section to appear in the **2D Viewer**.



Controls in this dialog box

Control	Purpose
Selected section	Name of selected section
Update in 3D Viewer	When checked, 3D GeoModeller updates the **3D Viewer** when you change data in the section
Display control of section elements	Types of elements for display
Other data	Types of data for display that do not belong to the section
Model geology	Types of model geology for display
Details of section elements	Details of section elements: Select a type of element then choose **Details**

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Image Manager dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to manage the images associated with a section. You can import, geolocate, show, hide or delete an image.

Controls in this dialog box

Control	Purpose
Section	Section to which the image is imported
Images	List of the section's imported images. See How to select items from a list.
New	See Edit and Align Image dialog box
Edit	See Edit and Align Image dialog box
Delete	Delete selected image
Show	Display selected image on section
Hide	Hide selected image

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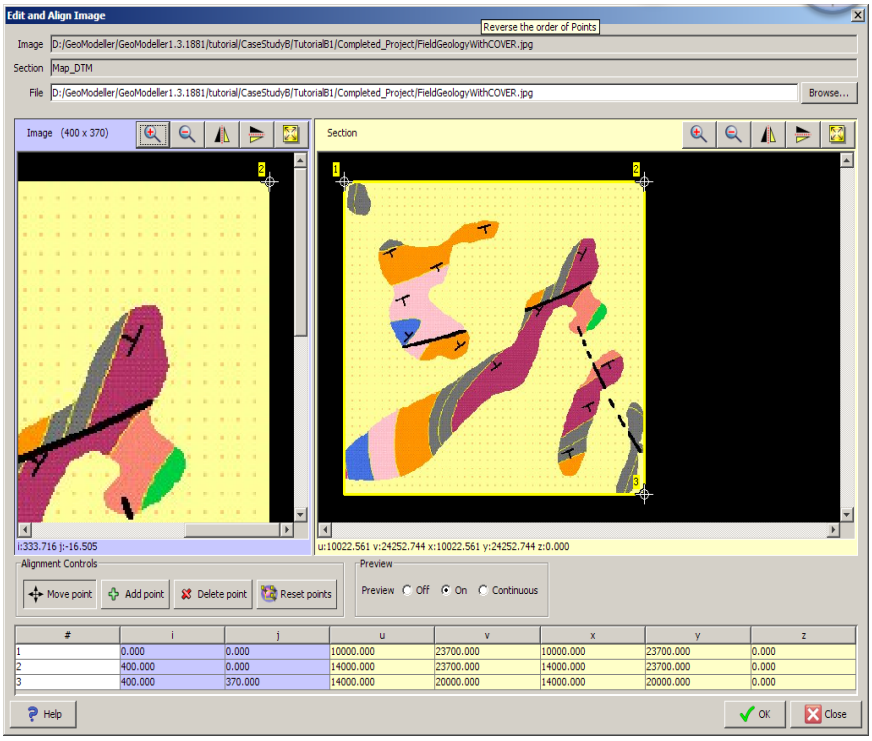
Edit and Align Image dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to geolocate an image on a section. Locate and mark three points on the image whose section coordinates you know.



Controls in this dialog box

Elements	Purpose	Tools
Image	Path of the loaded image	
Section	Section with which the image is associated	
File, Browse	Path and file name of image being loaded. Use **Browse** to navigate to the file. For information about supported image file formats, see File Formats—Images.	
Image panel	The loaded image with source control points. You can move the control points to the known locations in the image	
Section panel	The image as it appears in the section. You can move the target control points: • To match features visually or • To match known coordinate values in the points data ares	
Image and Section panel toolbar		
Zoom in **Zoom out**	Enlarge or reduce the image display	

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Elements	Purpose	Tools
Invert points	Mirror the image and points in a vertical axis	
Reverse points	Mirror the image and points in a horizontal axis	
Reset	Fit the image into the panel	
Alignment controls (mouse modes)		
Move point	Move points by dragging	
Add point	Add new points by clicking required positions. **Note:** Additional points (beyond 3) are not necessary for geolocation and will not straighten warped images	
Delete point	Delete points by clicking them	
Reset points	Move points to their original positions (Points 1, 2, 3 in corners of the image)	
Preview	**Off**: Target image hidden **On**: Preview of target image refreshes at the end of each point movement **Continuous**: Preview of target image refreshes continuously during point movements	
Points data	Table of point coordinates showing coordinates of each point in the Image and Section panels. You can: • Edit these values directly and 3D GeoModeller updates the panels. • Move the points in the panels and 3D GeoModeller updates the coordinates **i, j**: Pixel coordinates in the **Image** panel **u, v**: Section coordinates in the **Section** panel **x, y, z**: Project coordinates in the **Section** panel	

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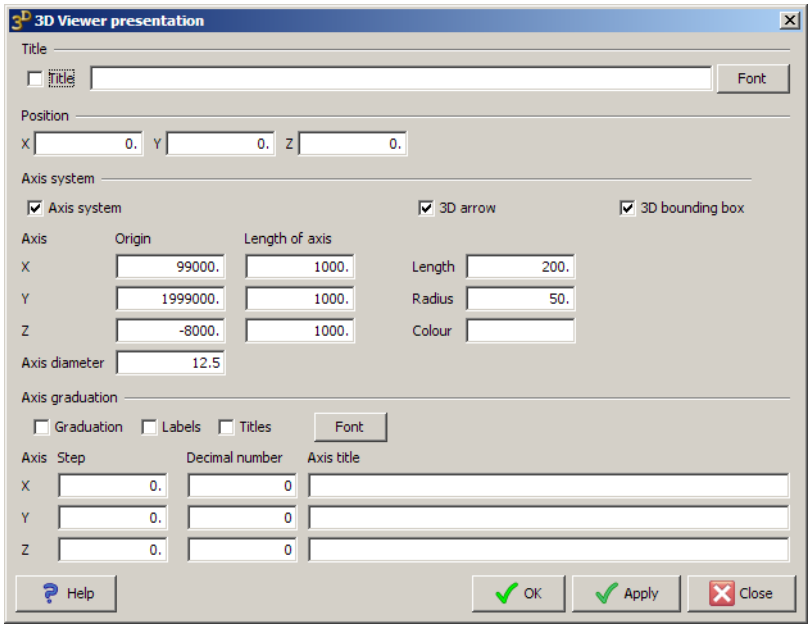
3D Viewer Presentation dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to specify the publishing annotations for a 3D view, including title, position of title and axis properties.



Controls in this dialog box

Control	Purpose
Title	Title text. Use **Font** to set the typeface and size
Position	Location of title
Axis system	
Axis graduation	
Axis step	
Decimal number	Number of decimal places in axis tick number
Axis title	Axis title

Note

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Load Surface Mesh

Parent topic: View menu and dialog boxes

You can load triangulated surfaces and volumes as visual layers.

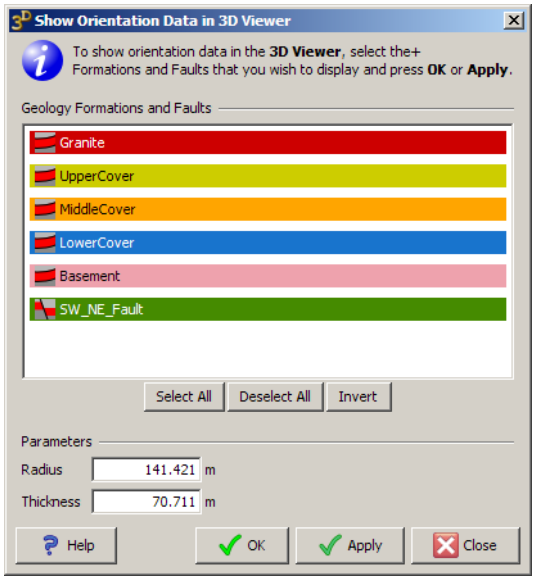
Supported formats:

- TSurf (GoCAD)
- Vulcan
- DXF
- BRep

Show Orientation Data in 3D Viewer dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to select formations whose orientation data points you want to see in the **3D Viewer**. You can also specify the appearance of the points.



Controls in this dialog box

Control	Purpose
Geology formations and faults	Geology formations and faults with orientation data available for display. See How to select items from a list.
Parameters	3D GeoModeller shows orientation data using disc symbol. You can set the **Radius** and **Thickness** of the symbols (in Project distance units)

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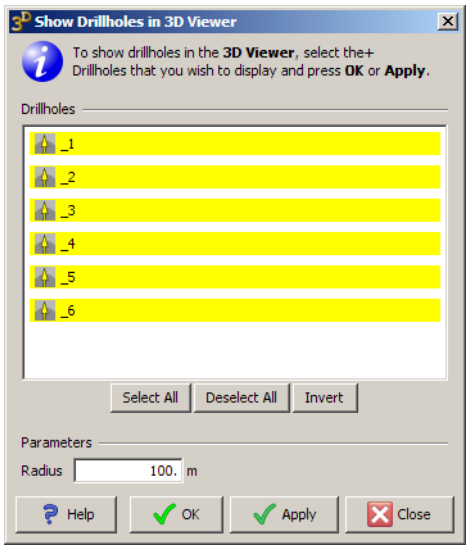
Show Drillholes in 3D Viewer dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to select drillholes for display in the **3D Viewer** and specify their appearance.



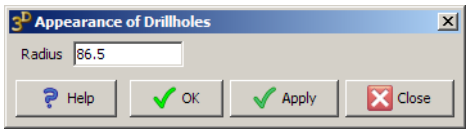
Controls in this dialog box

Control	Purpose
Drillholes	Drillholes available for display. See How to select items from a list.
Parameters	3D GeoModeller shows drillholes using cylinders. You can set the **Radius** of the cylinders (in Project distance units). The default radius is equal to 1/100 of the longest dimension of the Project.

Appearance of Drillholes dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to specify the display radius of one or more drillholes.



Controls in this dialog box

Control	Purpose
Radius	Display radius for the drillhole, in Project distance units (metres). The default radius is equal to 1/100 of the longest dimension of the Project.

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Show Interface Data in 3D Viewer dialog box

Parent topic: View menu and dialog boxes

Use this dialog box to specify the formations whose geology data points appear in the 3D Viewer.

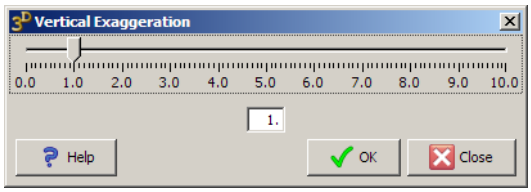
Controls in this dialog box

Control	Purpose
Geology formations and faults	Geology formations and faults with interface data available for display. See How to select items from a list.

Vertical Exaggeration dialog box

Parent topic: View menu and dialog boxes

Use his dialog box to set the vertical exaggeration factor in the **2D Viewer** or **3D Viewer**



Controls in this dialog box

Control	Purpose
Vertical exaggeration	Vertical exaggeration factor. See Vertical exaggeration

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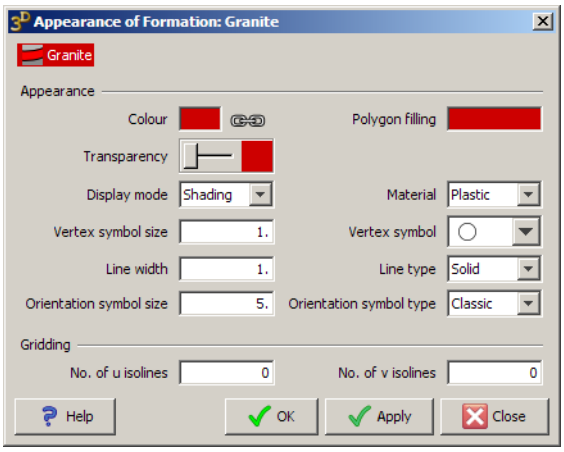
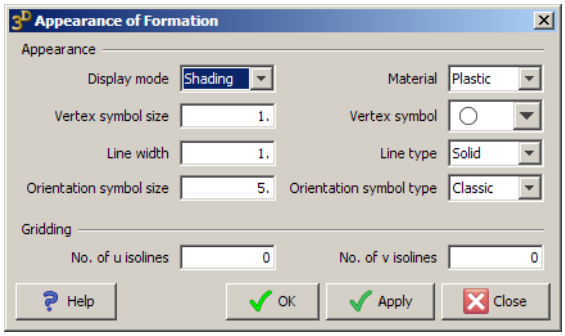
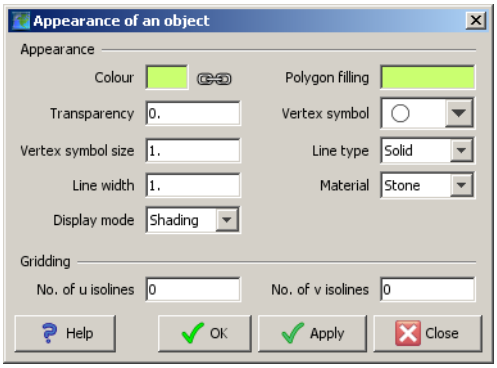
Appearance of objects dialog box family

Parent topic: View menu and dialog boxes

Use these dialog boxes to specify the display of objects. The dialog boxes vary slightly depending on the type of object you are configuring.







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Controls in this dialog box

Control	Purpose
Appearance	
Colour	*(Single formation or fault properties only)* Colour of formation. See Colour Palette dialog box.
Polygon filling	*(Single formation or fault properties only)* You can select a different fill colour for the formation. If you set the main colour for the formation, 3D GeoModeller overwrites this setting with the new formation colour.
Transparency	*(Single formation or fault properties only)* Transparency of fill in **3D Viewer**
Display mode	Shading or wireframe
Material	Reflective properties of fill in **3D Viewer**
Vertex symbol size	*(Contact data)* Radius of symbol
Vertex symbol	*(Contact data)* Shape of symbol
Line width	Width of plotted geological model lines
Line type	Line type (solid, dotted, dashed) of plotted geological model lines
Orientation symbol size	Size of orientation data symbols
Orientation symbol type	Type (classic, standard map) of orientation data symbol. See: • Orientation data plot symbols • Overturned geology
Gridding	
No of u, v isolines	For topography: number of lines in a grid that shows the topographic surface. For other uses: Contact our support service for information

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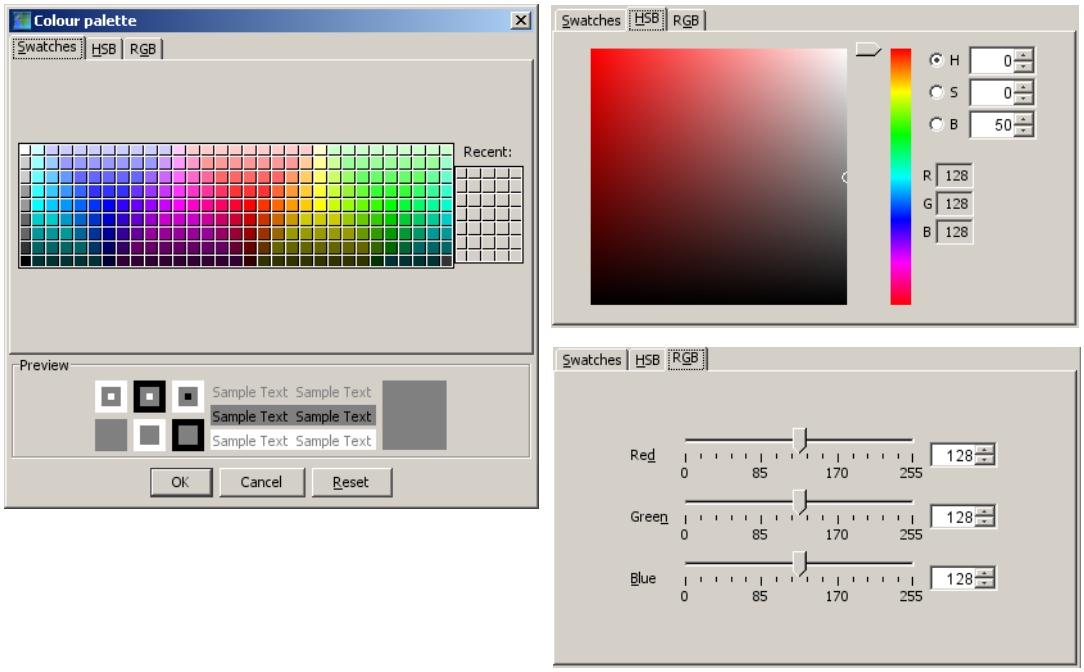
Colour Palette dialog box

Parent topic: View menu and dialog boxes

Whenever you choose a colour for something, 3D GeoModeller displays the **Colour palette** dialog box.



Controls in this dialog box

Control	Purpose
Swatches tab	Select the required colour from the palette.
HSB tab	The Hue, Saturation and Brightness tab. Set values using the text boxes, spin boxes or selection panels. In the square selection panel, Brightness corresponds to the vertical location and Saturation to the horizontal location. The tall narrow panel is for selecting Hue. 3D GeoModeller displays the corresponding RGB values for your selection.
RGB tab	The Red, Green, Blue tab. Set Red, Green and Blue using the sliders, text boxes or spin boxes.
Preview	The Preview panel shows your selected colour in a variety of contexts.
Reset	Resets the colour to the default for that object.

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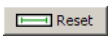
Column width controls

Parent topic: View menu and dialog boxes

When 3D GeoModeller displays data in columns, you can adjust the width of the columns using these controls.

Controls

Control	Purpose
Column size: auto	When checked, 3D GeoModeller automatically sets the column size
Column expand	Increase column width
Column shrink	Decrease column width
Column reset 	Reset column width

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Point Acquisition Parameters dialog box

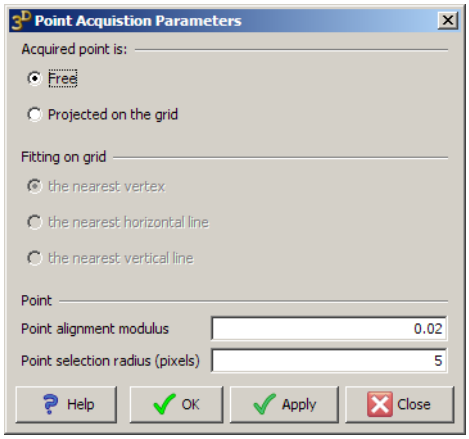
Parent topic: View menu and dialog boxes

This dialog box enables you to define the parameters for optional 'snap-to' positioning of a point, relative to already existing 2D grids and shapes.

You can:

- Position the point yourself OR
- Set 3D GeoModeller to 'snap' the selected point to a grid. In effect 3D GeoModeller simply rounds the coordinates of the point to a multiple of a 'modulus' (number) that you specify.

You can also specify how close the mouse pointer needs to be to a point for you to be able to select it.



Controls in this dialog box

Control	Purpose
Acquired point is	**Free**: 3D GeoModeller creates each new point exactly at the position that you click **Projected on the grid**: 3D GeoModeller rounds the values of new point coordinates according to the **Point alignment modulus**
Fitting on grid	*(If you selected **Projected on the grid**)* You can round the values of new point coordinates in either or both dimensions: • **The nearest mesh node**: Round both the U and V coordinates OR • **The nearest horizontal line**: Round only the U coordinate OR • **The nearest vertical line**: Round only the V coordinate

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Control	Purpose
Point alignment modulus	*(If you selected **Projected on the grid**)* Rounding number for coordinates of new points. When you create a new point, 3D GeoModeller rounds its coordinates to the nearest multiple of this number. For example if you set it to 100 and create new points, 3D GeoModeller creates points with coordinates that are multiples of 100.
Point selection radius	*(When you are selecting points in the **2D Viewer**)* Radius (in pixels) within which you can select a nearby point using the mouse. If this is a small number, you can only select a point when the mouse pointer is close to it. If there are several nearby points, 3D GeoModeller selects the one nearest to the mouse pointer

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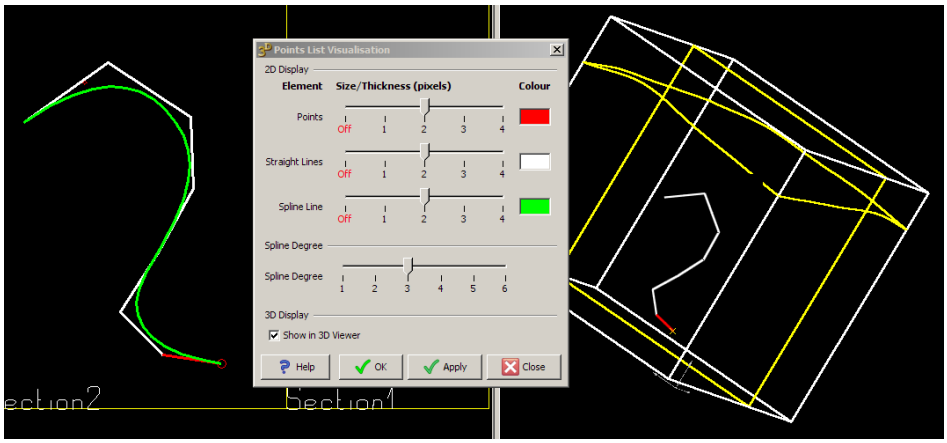
Points List Visualisation dialog box

Parent topic: View menu and dialog boxes

The **Points List Visualisation** dialog box enables you to specify how points appear in viewers when you create them in the points list.



Controls in this dialog box

Control	Purpose
2D display	
Points	Colour of current point in the **Point List** and colour and thickness of straight line from previous point to current point in the sequence of entry. To hide the current point and previous line segment, set the slider to **Off**. (Lines joining each pair of points remain unchanged.)
Straight lines	Colour and thickness of lines joining each pair of points in the sequence entered except for the current point and the point before it. To hide the lines joining each pair of points, set the slider to **Off**. (Current point and previous line segment remain unchanged.)
Spline line	Colour and thickness of spline line showing the smooth curve through the sequence of points. To hide the spline line, set the slider to **Off**.
Spline degree	Degree of spline in spline line. Degree 1 follows the lines exactly and is not visible as a separate line in the display. Degrees 2 – 5 show smooth curves of increasing generality, higher degrees following the lines less closely.
3D display	
Show in 3D Viewer	When checked, 3D GeoModeller displays the points and lines in the **3D Viewer**.

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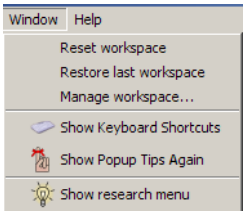
Window menu and dialog boxes

Parent topic: 3D GeoModeller main menus

The **Window** menu has options for the 3D GeoModeller workspace and user interface.



See the following table for an overview of the **Window** menu

Control	Purpose
Reset workspace	Reset the workspace so that the **2D Viewer** and **3D Viewer** are of equal size and the **2D Viewer** contains the Topography
Restore last workspace	Reorganise the workspace to match its layout last time you saved the project.
Manage workspace	Show or hide workspace components. See Docking configuration dialog box.
Show keyboard shortcuts	View a summary of all 3D GeoModeller keyboard shortcuts. See Keyboard shortcuts window.
Show pop-up tips	Contact our technical support service for information about this option.
Show research menu	Contact our technical support service for information about this option.

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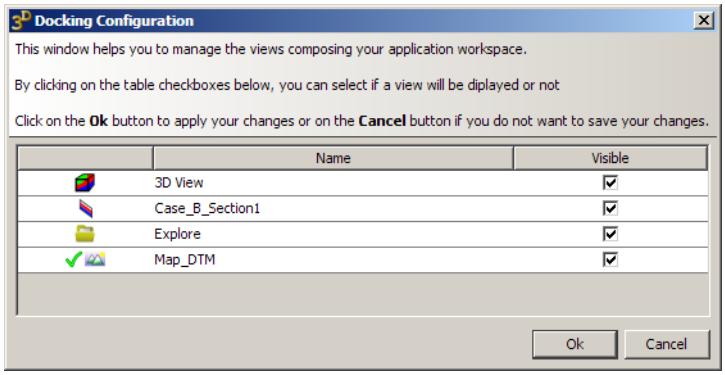
Docking configuration dialog box

Parent topic: Window menu and dialog boxes

Use the **Docking Configuration** dialog box to show and hide the current screen elements, such as **2D Viewer** windows and the **Project Explorer**.


Docking Configuration
This window helps you to manage the views composing your application workspace.
By clicking on the table checkboxes below, you can select if a view will be diplayed or not
Click on the Ok button to apply your changes or on the Cancel button if you do not want to save your changes.
Name
Visible
3D View
Case_B_Section1
Explore
Map_DTM
Ok
Cancel

Controls in this dialog box

Control	Description
Icon	Icon representing the window element
Name	Name of window element
Visible	Check to show. Clear to hide.

Keyboard shortcuts window

Parent topic: Window menu and dialog boxes

The **Keyboard Shortcuts** window has a complete list of all 3D GeoModeller keyboard shortcuts.

Command	Keystroke
File operations (see Project menu, Project toolbar and dialog boxes)	
New	CTRL+N
Open	CTRL+O
Close	CTRL+W
Save	CTRL+S
Save as	CTRL+SHIFT+S
Print	CTRL+P
Quit	CTRL+Q
Points list (see Points List toolbar (docked), Points List Editor (floated))	
Go back 10 points	CTRL+[
Go to previous point	[
Go forwards 10 points	CTRL+]
Go to next point	]
Delete all points	CTRL+DELETE

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Command	Keystroke
Delete selected points	DELETE
Move selected points up in list	U
Move selected points down in list	D
Reverse the order of points	\
Float or dock the Points List Editor	CTRL+L
2D viewer controls (see 2D Viewer toolbar)	
Section controls (see Section menu, toolbar and dialog boxes)	
Create a section from its trace	CTRL+T
Create a horizontal section	CTRL+U
2D structural data (see 2D Structural sub menu and Structural toolbar)	
Create geology data	CTRL+G
Create geology orientation data	CTRL+R
Fit a plane to points and create orientation data	CTRL+F
Create axial surface data (an axial trace on a map	CTRL+B
Create axial surface orientation data	CTRL+K
Create hinge line data	CTRL+H
Model (see Model menu, toolbar and dialog boxes)	
Compute	CTRL+M
Plot the model settings	CTRL+D
Project data onto sections	CTRL+I
Plot the model along section intersections	CTRL+E

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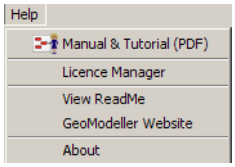
Help menu and dialog boxes

Parent topic: 3D GeoModeller main menus

The **Help** menu has options for viewing the 3D GeoModeller manual, website, **readme**, licence and version.



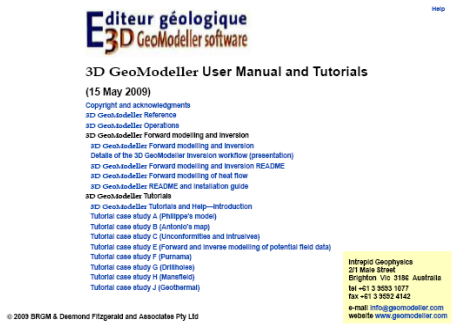
See the following table for an overview of the **Help** menu

Control	Purpose
Manual and tutorial (PDF)	See User manual and tutorials.
Licence manager	See Licence manager.
View ReadMe	Choose this option to view the 3D GeoModeller **readme** file, which contains installation and configuration instructions and last minute updates
GeoModeller website	Choose this option to visit the 3D GeoModeller website http://www.geomodeller.com
About	See About 3D GeoModeller dialog box.

User manual and tutorials

Parent topic: Help menu and dialog boxes

The PDF version of the user manual contains all reference, instructions and case study tutorials. The same reference information for 3D GeoModeller windows and dialog boxes also appears as context-sensitive help when you press F1 or choose a **Help** button.


Editeur géologique
3D GeoModeller software
3D GeoModeller User Manual and Tutorials
(15 May 2009)
Copyright and acknowledgments
3D GeoModeller Reference
3D GeoModeller Operations
3D GeoModeller Forward modelling and inversion
3D GeoModeller Forward modelling and inversion
Details of the 3D GeoModeler inversion workflow (presentation)
3D GeoModeller Forward modelling and inversion README
3D GeoModeller Forward modelling of heat flow
3D GeoModeller README and installation guide
3D GeoModeller Tutorials
3D GeoModeller Tutorials and Help—introduction
Tutorial case study A (Philippe's model)
Tutorial case study B (Antonio's map)
Tutorial case study C (Unconformities and intrusives)
Tutorial case study E (Forward and inverse modelling of potential field data)
Tutorial case study F (Pumama)
Tutorial case study G (Drillhole)
Tutorial case study H (Mansfield)
Tutorial case study J (Geothermal)
Intrapid Geophysics
2/1 Male Street
Brighton Vic 3186 Australia
tel +61 3 9593 1077
fax +61 3 9592 4142
e-mail info@geomodeller.com
website www.geomodeller.com
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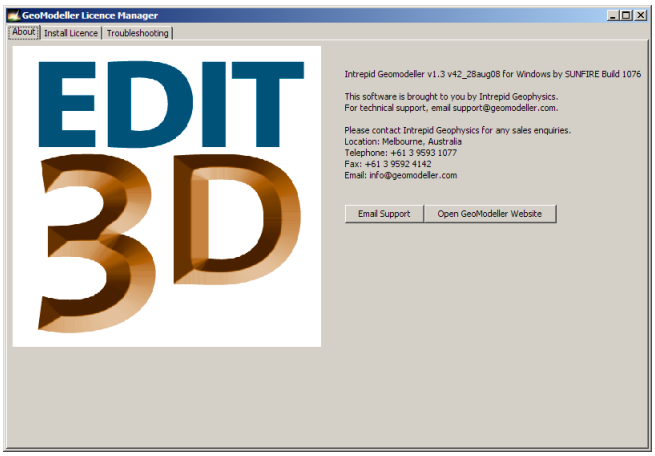
Licence manager

Parent topic: Help menu and dialog boxes

The **Licence Manager** enables you to view and manage your 3D GeoModeller licence. If you do not have a valid licence when you launch 3D GeoModeller, the Licence Manager window opens instead of 3D GeoModeller



Follow the instructions in the **Licence Manager**.

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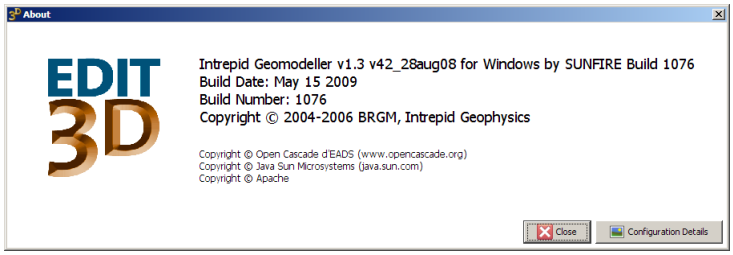
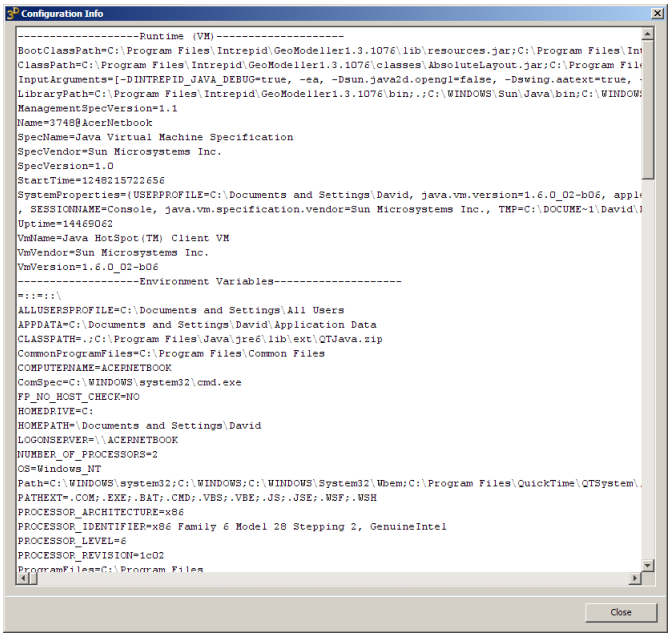
About 3D GeoModeller dialog box

Parent topic: Help menu and dialog boxes

The **About** dialog box shows the current 3D GeoModeller version and enables you to view configuration information.


About
EDIT 3D
Intrepid Geomodeller v1.3 v42_28aug08 for Windows by SUNFIRE Build 1076
Build Date: May 15 2009
Build Number: 1076
Copyright © 2004-2006 BRGM, Intrepid Geophysics
Copyright © Open Cascade d'EADS (www.opencascade.org)
Copyright © Java Sun Microsystems (java.sun.com)
Copyright © Apache
Close
Configuration Details

Choose **Configuration Details** to view configuration information for your installation of 3D GeoModeller.



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3D GeoModeller concepts

Parent topic: 3D GeoModeller Reference

This section contains a number of explanations of concepts that you may need to understand when using 3D GeoModeller.

In this section:

- Dynamic selection
- Precision in representing curves and surfaces
- Overturned geology
- Orientation data plot symbols
- Vertical exaggeration
- How to select items from a list

Dynamic selection

Parent topic: 3D GeoModeller concepts

If you enable this feature, you can automatically select objects in the **2D Viewer** when you point to the object. You can edit or delete selected data objects using the shortcut menu.

When enabled, you can select an object in the **2D Viewer** by pointing to it.

When not enabled, to select an object, you need to be in **Select** mode (see 2D Viewer toolbar) and then click the object. In this state you can select a number of objects. After selecting the first object hold down SHIFT to select more.

You can turn dynamic selection on and off in the **Project Properties** dialog box. See Project Properties dialog box.

Precision in representing curves and surfaces

Parent topic: 3D GeoModeller concepts

3D GeoModeller represents (curved) lines in the 2D Viewers and 3D Viewer by a succession of rectilinear segments ('discretisation') and manages them to give the best possible rendering of their shape.

In the same way, 3D GeoModeller represents surfaces an assemblage of triangles (of variable size) coupled one to another ('triangulation').

The quality of the representation of these curves and surfaces depends on the number of segments and triangles used. This quality is controlled by the three parameters:

Parameter	Description
2D Deflection	Maximum distance between a line segment and the corresponding curve in the model. Use this to manage the quality of rendering (curved) lines of modelled geology plots in the **2D Viewer**
3D Deflection	Maximum distance between a triangle and the corresponding part of the 3D model surface. Use this to manage the quality of rendering (curved) surfaces of modelled geology shapes in the **3D Viewer**
Discretisation	Diameter of an 'averaging' sphere within which to simplify the structural data (geology data and geology orientation data).

You can set these parameters in the **Project Properties** dialog box. See Project Properties dialog box.

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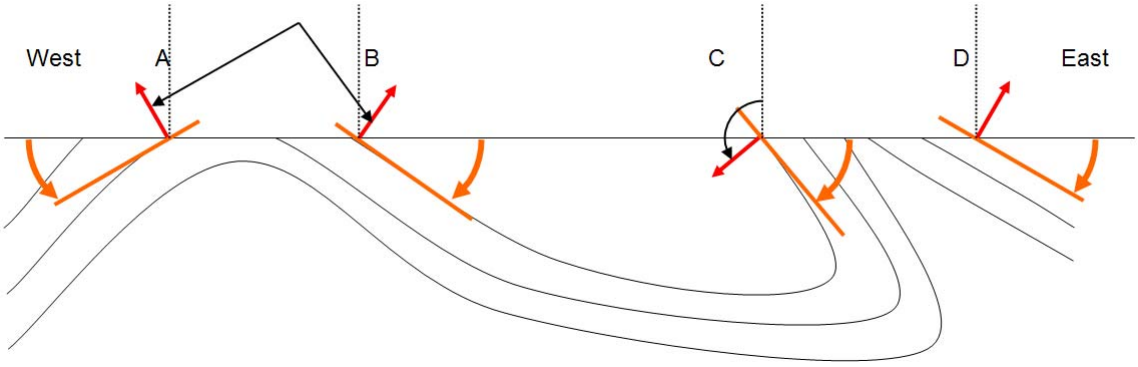
Overturned geology

Parent topic: 3D GeoModeller concepts

When specifying orientation data you need to tell 3D GeoModeller is the geology is overturned. The following illustration of a vertical section shows overturned data at location C.



3D GeoModeller shows orientation data as facing vectors, orthogonal to the local geology surface or feature.

The following illustration shows a table of values of the orientation data shown above.

	Traditional Geology Dip	GeoModeller Convention	The 'Facing Vector' is …
A	30° towards 270°	30° towards 270°, Polarity 1	30° from vert. towards 270°
B	35° towards 090°	35° towards 090°, Polarity 1	35° from vert. towards 090°
C	50° towards 090° ***Overturned***	50° towards 090°, ***Polarity –1*** … or … 130° towards 270°, Polarity 1	 130° from vert. towards 270°
D	30° towards 090°	30° towards 090°, Polarity 1	30° from vert. towards 090°

When you enter overturned geology data in 3D GeoModeller, set **Polarity** to –1.

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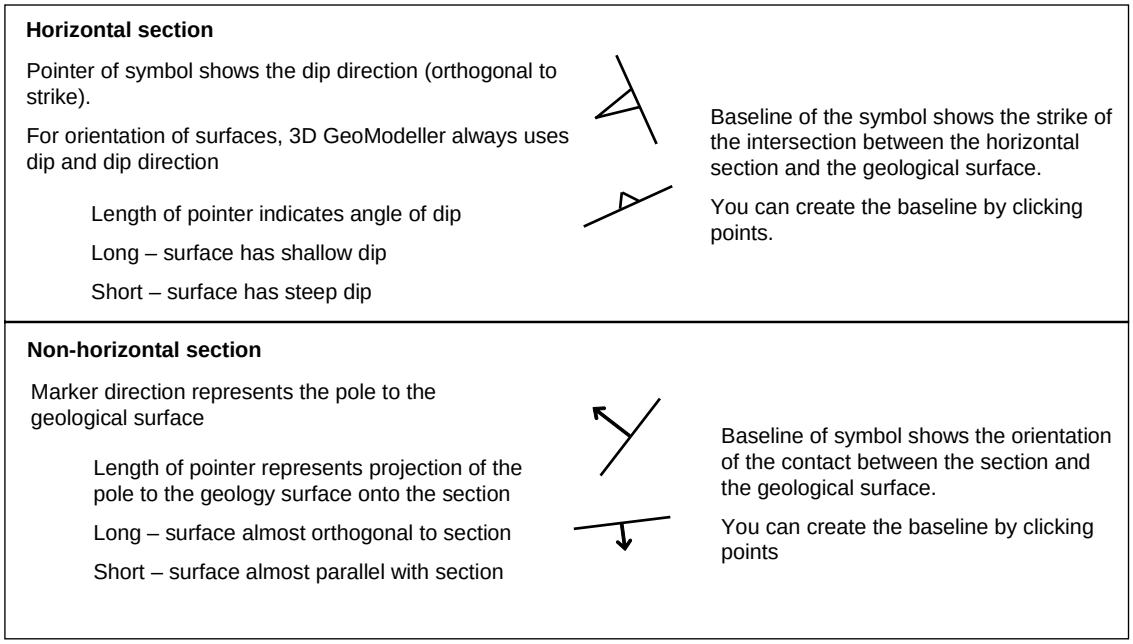
Orientation data plot symbols

Parent topic: 3D GeoModeller concepts

You can create an orientation point from two points in the **Points List** (in other words, by clicking two points). The following diagram has a guide to the default 3D GeoModeller orientation point symbols.

Orientation data markers—3D GeoModeller default conventions


Horizontal section
Pointer of symbol shows the dip direction (orthogonal to strike).
For orientation of surfaces, 3D GeoModeller always uses dip and dip direction
Length of pointer indicates angle of dip
Long – surface has shallow dip
Short – surface has steep dip
Baseline of the symbol shows the strike of the intersection between the horizontal section and the geological surface.
You can create the baseline by clicking points.
Non-horizontal section
Marker direction represents the pole to the geological surface
Length of pointer represents projection of the pole to the geology surface onto the section
Long – surface almost orthogonal to section
Short – surface almost parallel with section
Baseline of symbol shows the orientation of the contact between the section and the geological surface.
You can create the baseline by clicking points

You can change the symbols if required. See Appearance of objects dialog box family

Entering orientation data points using the Points List

You can use the **Points List** to create an orientation point. 3D GeoModeller creates the line component (not the arrow) parallel to the line joining the two most recent points in the **Points List**. This has a different significance in horizontal and vertical sections (see following sections).

You can edit the line later in the **Create (or Edit) Orientation Data** dialog box or the **Create (or Edit) Axial Surface Orientation Data** dialog box at any time. See:

- Create (or Edit) Geology Data dialog box
- Create (or Edit) Axial Surface Orientation Data dialog box

See also Editing geological data with the Points List.

Horizontal section orientation markers

If you use the **Points List** to create an orientation point in a horizontal section, 3D GeoModeller sets the dip direction the same as the line joining the two points.

The direction in which you click the two points is important for the dip. If you want to enter the dip as an angle between 0° and 90°, then you need to click the two points in the direction where the dip falls away to the left.

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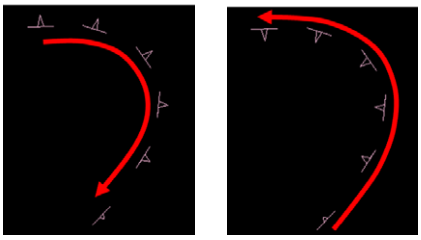
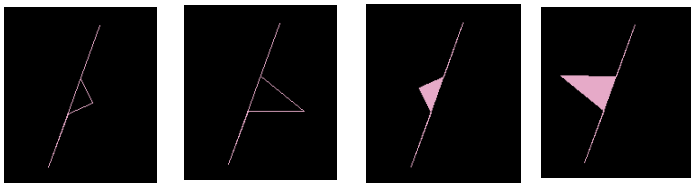
The following diagram shows a number of orientation points in a horizontal section. the large arrows show the direction in which the user clicked the points of each observation.



We show the overturned dips with their conventional dip direction, with a filled triangle symbol to indicate that they are overturned. The following diagram has examples.



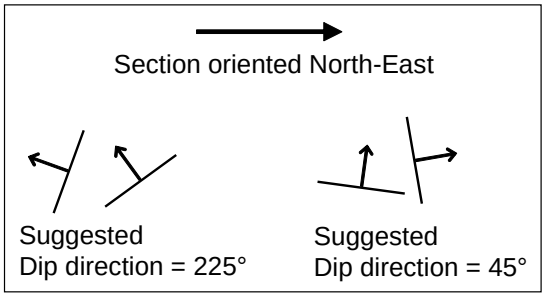
45° to 110° **75° to 110°** **75° to 290° overturned** **45° to 290° overturned**

Non-horizontal section orientation markers

If you are clicking points to input orientation data on a non-horizontal section, the two points you click represent the observed dip of the contact between the surface and the section.

In the in the **Create or Edit Orientation Data** dialog box, 3D GeoModeller shows:

- **Dip** as the angle between 0° and 90° above the horizontal of the line between the points you clicked
- **Dip direction** as the direction from left to right or right to left of the section at the clicked points. For example, if the section is oriented North-East, it shows **Dip direction** as either 45° or 225°. See the following diagram for an illustration.



In suggesting these values 3D GeoModeller is assuming that the geological surface is orthogonal to the section and so has the Dip direction of 45° (North-East) or 225° (South-West).

If you know the true dip of the surface, edit the **Dip** and **Dip direction** to show the correct values.

There is no special symbol for overturned in a non-horizontal section.

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Vertical exaggeration

Parent topic: 3D GeoModeller concepts

A vertical exaggeration factor of 1 results in height scale being the same as horizontal scale.

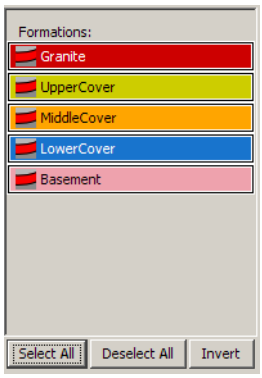
For example, if there is no vertical exaggeration (factor = 1), then if you add 1 to the factor. the vertical exaggeration becomes 2 and 3D GeoModeller shows height at twice the actual size relative to horizontal distances. If you add 1 again, 3D GeoModeller displays at three times actual height relative to horizontal distances.

There is no vertical exaggeration in topographic sections.

How to select items from a list

Parent topic: 3D GeoModeller concepts

In various places while using 3D GeoModeller you need to select one or more items from a list. 3D GeoModeller has a standard set of options for this.



Controls for selecting items

Operation	Control	Mouse and keyboard
Select one item		Click the item
Select a number of separate items		Click the first item. Hold down CTRL and click the other items
Deselect a single selected item		Hold down CTRL and click selected item that you want to deselect
Select a range of items		Click the first item. Hold down SHIFT and click the last item
Select all items	**Select all**	
Deselect all items	**Deselect all**	
Invert the selection so that selected items become deselected and deselected items become selected	**Invert**	

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How 3D GeoModeller imports the DTM

Parent topic: 3D GeoModeller Reference

3D GeoModeller can import DTMs from a variety of formats. It applies checks and corrections before accepting the data into the model.

In this section:

- Datum and projection DTM import checks
- Spatial extent DTM import checks
- Wireframe format (DXF) DTM import
- DTM data sources—NASA SRTM data

See also

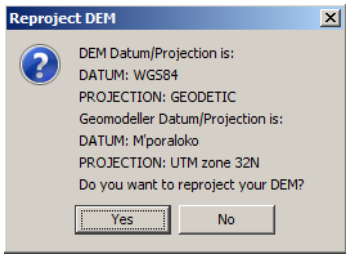
- File Formats—Digital terrain model
- Load Topography from a DTM dialog box

Datum and projection DTM import checks

Parent topic: How 3D GeoModeller imports the DTM

When importing a digital terrain model (DTM) in a format containing datum and projection properties (all formats except **semi**, **gdm** and **dxf**), 3D GeoModeller compares these properties with those of the 3D GeoModeller project.

If the DTM datum and projection does not match the one defined in the 3D GeoModeller project, 3D GeoModeller displays the **Reproject DEM** dialog box, asking if you want to reproject the DTM (DEM is an alternative term for DTM, digital elevation model).



3D GeoModeller supports SRTM DTMs in the WGS84 GEODETIC (Latitude Longitude) datum and projection in the reprojection process. It supports most datums for Transverse Mercator UTM projections although there may be a lack of support for less common datum and projection pairs. If you require a particular datum and projection please contact our support service.

If you choose **Yes**:

3D GeoModeller reprojects the DTM into the project's datum and projection. If the required transform parameters are not available, 3D GeoModeller displays an error message.

To override the datum and projection mismatch, choose **OK**. 3D GeoModeller attempts to load the DTM without reprojection.

If you choose **No**:

3D GeoModeller returns to the **Load topography from a DTM** dialog box (see Load Topography from a DTM dialog box). Use **Browse** or type the path of an alternative DTM.

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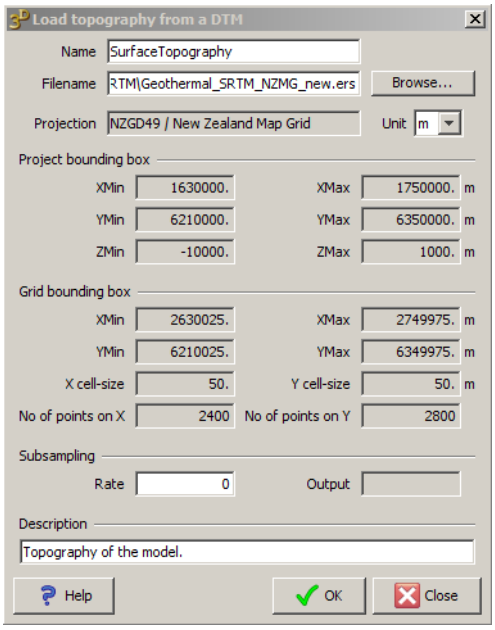
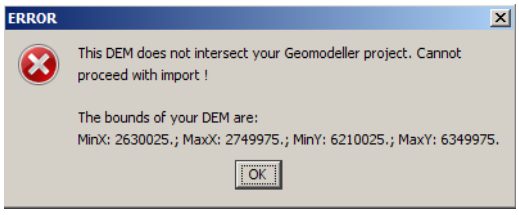
Spatial extent DTM import checks

Parent topic: How 3D GeoModeller imports the DTM

3D GeoModeller performs spatial extents checking when importing a DTM to a project as follows:

1 If the DTM does not intersect the project extents 3D GeoModeller warns you and does not perform the import. 3D GeoModeller displays feedback on the actual DTM extents compared to the project extents.




ERROR
This DEM does not intersect your Geomodeller project. Cannot proceed with import !
The bounds of your DEM are:
MinX: 2630025.; MaxX: 2749975.; MinY: 6210025.; MaxY: 6349975.
OK

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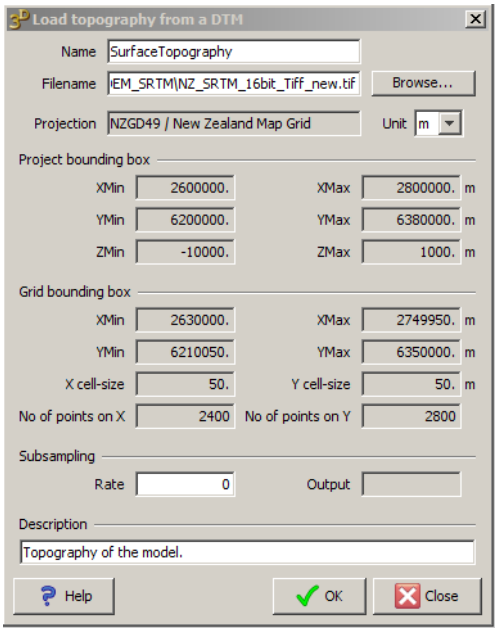
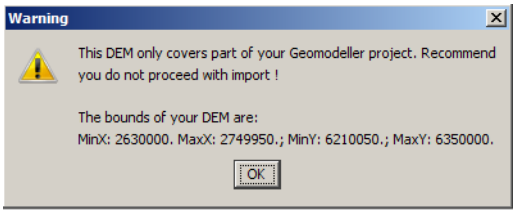
2 If the DTM does not cover the full extents of the project, 3D GeoModeller warns you and does not perform the import. 3D GeoModeller displays feedback on the actual DTM extents compared to the project extents.

You can continue with the import but we do not recommend it. If you continue, 3D GeoModeller attempts to extrapolate the DTM to cover the project extents using a spline interpolator, often with poor results, particularly in areas of high topographic relief.




Warning
This DEM only covers part of your Geomodeller project. Recommend you do not proceed with import !
The bounds of your DEM are:
MinX: 2630000. MaxX: 2749950.; MinY: 6210050.; MaxY: 6350000.
OK

3 If the DTM contains a large number of nulls around the perimeter, 3D GeoModeller does not take them into account when computing the DTM extents. This can affect the quality of the imported DTM, as 3D GeoModeller attempts to fill any holes as described in the previous step. We recommend that before import you fill Null holes or Null perimeters in the DTM using publicly available SRTM data (see DTM data sources—NASA SRTM data).

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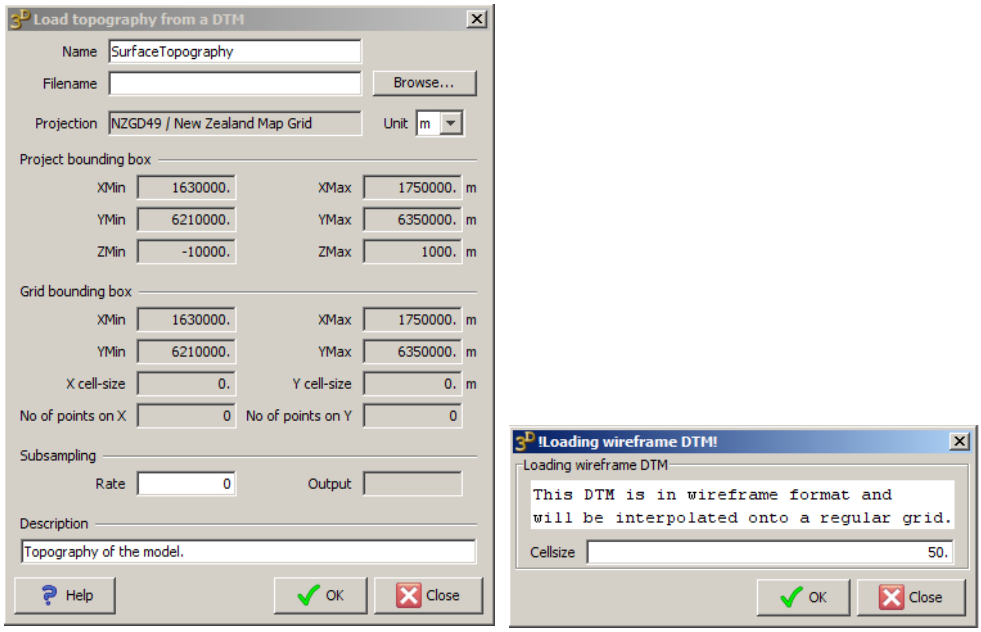
Wireframe format (DXF) DTM import

Parent topic: How 3D GeoModeller imports the DTM

3D GeoModeller can import a topographic surface (DTM) as a 3D DXF (wireframe). Currently it expects a 3DFACE DXF primitive but can also handle 3D polyline primitives as may be found in contour maps or 3D points as in spot heights. It extracts, grids and saves the DXF height information to an ERMapper grid file and then imports in one operation using the same extent tests described above. Currently 3D GeoModeller does not respond if the DXF file contains unsupported primitives.

If the DXF file contains the required primitives, 3D GeoModeller displays the **Loading wireframe DTM** dialog box.



Select the grid cell size for the output DTM grid.

DTM data sources—NASA SRTM data

Parent topic: How 3D GeoModeller imports the DTM

If you do not have a DTM for your 3D GeoModeller Project then an excellent source of publicly available 3 arc minute (90m) resolution NASA Shuttle Radar Topographic Mission (SRTM) digital elevation data is available from the CGIAR-CSI (CGIAR Consortium for Spatial Information) website at http://srtm.csi.cgiar.org/

Data is available in 5° x 5° tiles in WGS84 Geodetic projection in both GeoTIFF and Arc ASCII format. On the home page you can find the following detailed information on quality and value added processing of the available SRTM data (adapted). The text contains the alternative term DEM (digital elevation model) which is the same as DTM.

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The CGIAR-CSI GeoPortal can provide SRTM 90m digital elevation data for the entire world. The SRTM digital elevation data, produced by NASA originally, is a major breakthrough in digital mapping of the world, and provides a major advance in the accessibility of high quality elevation data for large portions of the tropics and other areas of the developing world. The SRTM digital elevation data provided on this site has been processed to fill data voids, and make it easy for a wide group of potential users to use. NASA provides this data in an effort to promote the use of geospatial science and applications for sustainable development and resource conservation in the developing world.

A DTM for the entire globe, covering all of the countries of the world, is available for download on this site. The component SRTM 90m DEMs have a resolution of 90m at the equator, and are provided in mosaic-ed 5° x 5° tiles for easy download and use. They are all produced from a seamless dataset to allow easy mosaic-ing. These are available in both ArcInfo ASCII and GeoTIFF format to facilitate their ease of use in a variety of image processing and GIS applications. You can download data using a browser or access it directly from the FTP site. If you find this digital elevation data useful, please send e-mail to csi@cgiar.org

The NASA SRTM has provided digital elevation data (DEMs) for over 80% of the globe. USGS currently distributes this data free of charge and it is available for download from the National Map Seamless Data Distribution System, or the USGS FTP site. The SRTM data is available as 3 arc second (approx. 90m resolution) DEMs. A 1 arc second data product was also produced, but is not available for all countries. The vertical error of the DEMs is reported to be less than 16m. The data currently being distributed by NASA and USGS (finished product) contains 'no-data' holes where water or heavy shadow prevented the quantification of elevation. These are generally small holes, which nevertheless render the data less useful, especially in fields of hydrological modelling.

Dr. Andy Jarvis and Edward Guevara of the CIAT Agroecosystems Resilience project, Dr. Hannes Isaak Reuter (JRC-IES-LMNH) and Dr. Andy Nelson (JRC-IES-GEM) have further processed the original DEMs to fill in these no-data voids. This involved the production of vector contours and points, and the re-interpolation of these derived contours back into a raster DEM. These interpolated DEM values are then used to fill in the original no-data holes within the SRTM data. These processes were implemented using ArcInfo and an AML script. The DEM files have been mosaiced into a seamless near-global coverage (up to 60 degrees north and south), and are available for download as 5° x 5° tiles, in geographic coordinate system—WGS84 datum. These files are available for download in both ArcInfo ASCII format, and as GeoTIFF, for easy use in most GIS and Remote Sensing software applications. In addition, a binary Data Mask file is available for download, allowing you to identify the areas within each DEM that have been interpolated.

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Model interpolation parameters

Parent topic: 3D GeoModeller Reference

This section explains how you can control the way 3D GeoModeller interpolates data and includes examples.

For details about how to set interpolation parameters in 3D GeoModeller, see Model Interpolation Parameters dialog box.

In this section:

- Introduction to interpolation concepts and parameters
- Interpolation examples—Introduction
- Interpolation example 1—Isotropic
- Interpolation example 2—Anisotropic—No Axes Rotation, Limited Z range
- Interpolation example 3—Anisotropic—No Axes Rotation, Large Z Range
- Interpolation example 4—Anisotropic—no Axes Rotation, Large X Range
- Interpolation example 5—Anisotropic—No Axes Rotation, Large X & Z Range
- Interpolation example 6—Anisotropic with Azimuth and Dip Rotation
- Interpolation example 7—Anisotropic with Azimuth, Dip and Pitch Rotation
- Interpolation example 8—Using Anisotropy to connect widely spaced outcrop data
- Notes about interpolation anisotropy

Introduction to interpolation concepts and parameters

Parent topic: Model interpolation parameters

Isotropic Properties and Range

3D GeoModeller's default settings assume that a formation or series has geometric properties that are isotropic. This means that the properties of the formation vary equally in all directions, the search neighbourhood for interpolation is spherical and is defined by a radius equal to the range parameter. The default range parameter is the diagonal length of the project bounding box.

Geological Contact and Orientation data

3D GeoModeller uses both geological contact data and orientation data (gradients) during interpolation. It uses co-kriging in its dual form to interpolate both types of data, assuming a cubic model. Orientation data (gradients or derivatives) have a much higher weighting than contact data (increments) in this dual process.

3D GeoModeller further controls interpolation using two additional kriging parameters usually derived by variogram modelling. See the following sections for a discussion of their estimation and impact.

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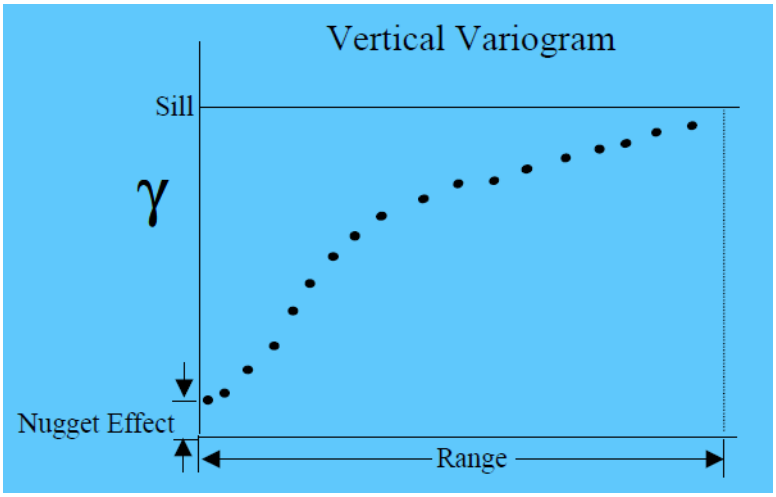
Nugget Effect

The **Nugget effect** is the error (variance) that remains when the sample spacing is zero. Two measurements at the same location give different results. This may be due to sampling error, erratic processes or geological micro structure. On a typical variogram this is where the fitted variogram line intersects the Y axis. In other words, semi-variance Ý is not zero when sample spacing is zero. See the diagram below.



In 3D GeoModeller we can think of the value assigned to the **Nugget effect** as the error allowed in fitting the model to the observed data during interpolation.

You can choose whether to force the data through the known data points or accept some error in order to produce a smoother model. This choice depends on how accurate you believe that your data points are in both a locational and a geological sense and whether there are sufficient observations to completely define the model.

You can set the **Nugget effect** for both contact data and orientation data separately. The smaller the **Nugget effect** the smaller the error in fitting the data. For instance if you are confident that your drill hole contacts are very accurate and there is very little other subsurface contact data then reducing the default **Nugget effect** on **Geology data** from 0.000001 to 0.00000001 will force the interpolated contacts to pass through the drill hole contacts with a much smaller error.

Drift

The **Drift** parameter allows you to control interpolation of the structural component of the data where the local trend varies from one location to another.

You can set Drift to zero (no drift, no predefined trend), one (linear, tends to planar) or two (quadratic tends to parabolic). The default is 1, tendency to planar. For sedimentary series this is generally true at most mapping scales and this parameter is seldom changed.

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Anisotropy

You can change the default isotropic interpolation behaviour to anisotropic.

This allows the geometric properties of a formation to be different in all directions, which can be useful for controlling the geometry of thin bodies such as dykes or pipe like intrusives. It may also reduce the number of observations required to model them.

Six Anisotropic parameters are available.

The first three are angles, **Azimuth**, **Dip** and **Pitch**. These allow you to orient the 3 axes of the ellipsoid to fit the geometry of the body being modelled.

The default values of zero for Azimuth, Dip and Pitch define ellipsoid axes parallel to the X, Y & Z coordinate axes of the project. Normally +X is East, +Y is North, +Z is Up (Elevation).

The last three parameters, **X_Range**, **Y_Range** and **Z_Range** are the interpolation range values in metres in the direction of each ellipsoid axis as defined by the three angles above. The range is the distance at which an observation or measurement is no longer spatially correlated with others; has no further impact on the interpolation.

Anisotropy—Angles

The default **Azimuth** of 0 is north, the direction of the +Y axis. A positive **Azimuth** rotates the Y axis in a clockwise direction around the Z axis; in the horizontal plane.

Dip is the angle of downward rotation of the y axis in the direction of the azimuth of the +Y axis. **Dip** is positive down in this direction in 3D GeoModeller not negative as defined in GSLIB (see diagrams below in this section).

The third rotation angle, **Pitch** leaves the principle direction or vector defined by **Azimuth** and **Dip** unchanged. The two directions perpendicular to the principle vector are rotated clockwise relative to the principle vector when looking towards the origin. The **Pitch** rotation appears to be anticlockwise since the view is away from the origin, (see diagrams below in this section).

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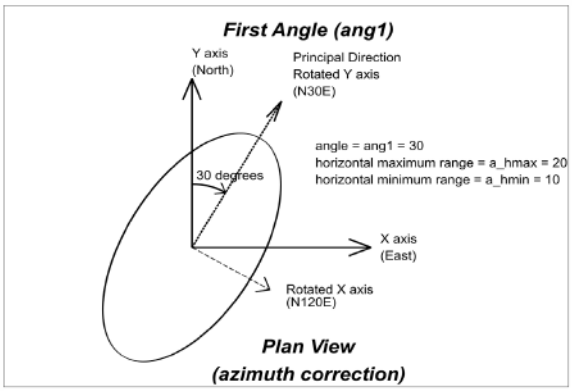
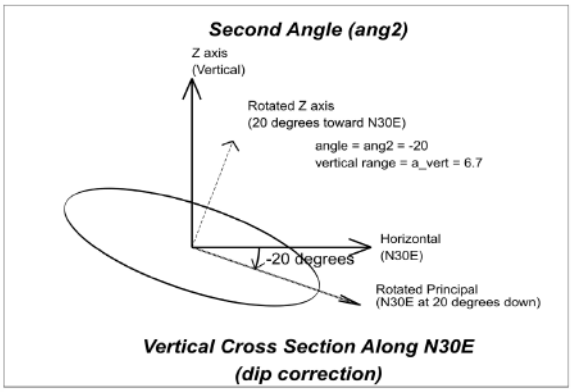
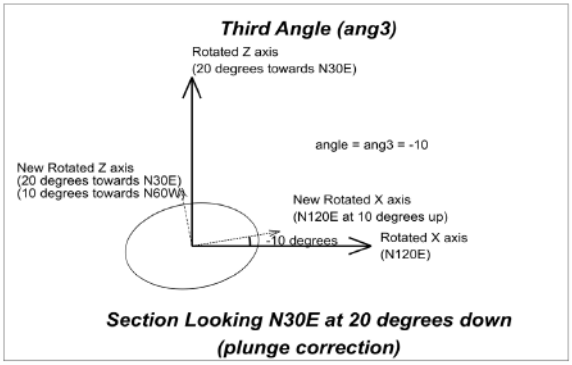


First Step



Second Step



Third Step

GSLib convention for axis rotations (Source: Deutsch and Journel, p 28. Note that the third step has been corrected. Diagram is from *Angle Rotations in GSLIB* by Chad Neufeld and Clayton V. Deutsch, Centre for Computational Geostatistics, Department of Civil and Environmental Engineering, University of Alberta.

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Anisotropy—Angles example

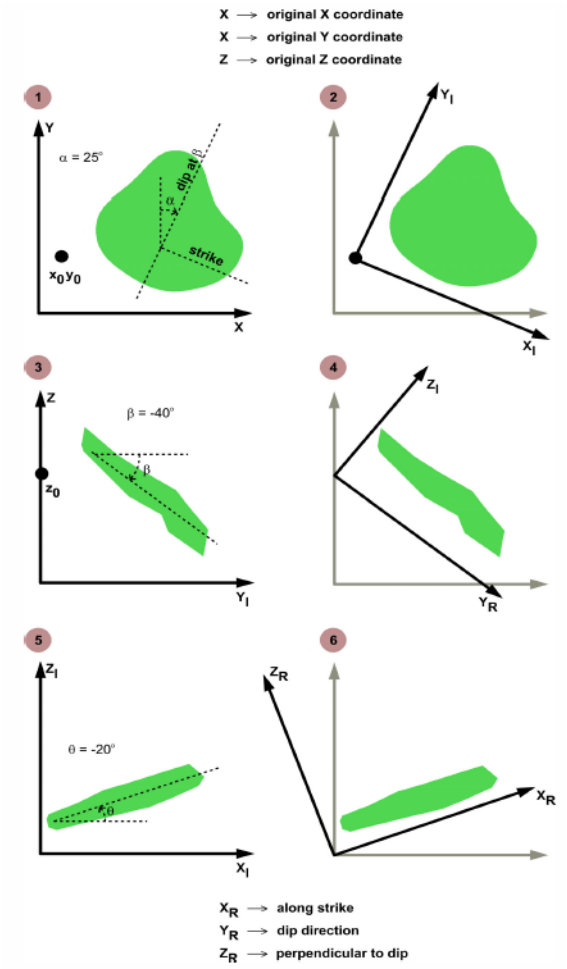
Consider the deposit shown in the diagram below. We want to align the X, Y, and Z axis to be along strike, down dip, and perpendicular to the structure respectively. This allows us to better characterise the anisotropy of the deposit.

The azimuth correction is the first rotation.

Setting ang1 = 25° aligns the Y axis with the dip and the X axis with the strike. The dip correction is the second rotation.

Setting ang2 = –40° aligns the Y axis down dip and the Z axis perpendicular to the dip. The plunge correction is the third rotation.

Setting ang3 = –20° aligns the X axis along strike and the Z axis perpendicular to the structure.



Example rotated coordinate system. Note that Dip is positive down in 3D GeoModeller not negative as shown in this diagram. Diagram is from *Angle Rotations in GSLIB* by Chad Neufeld and Clayton V. Deutsch, Centre for Computational Geostatistics, Department of Civil and Environmental Engineering, University of Alberta.

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Anisotropy—Range Values

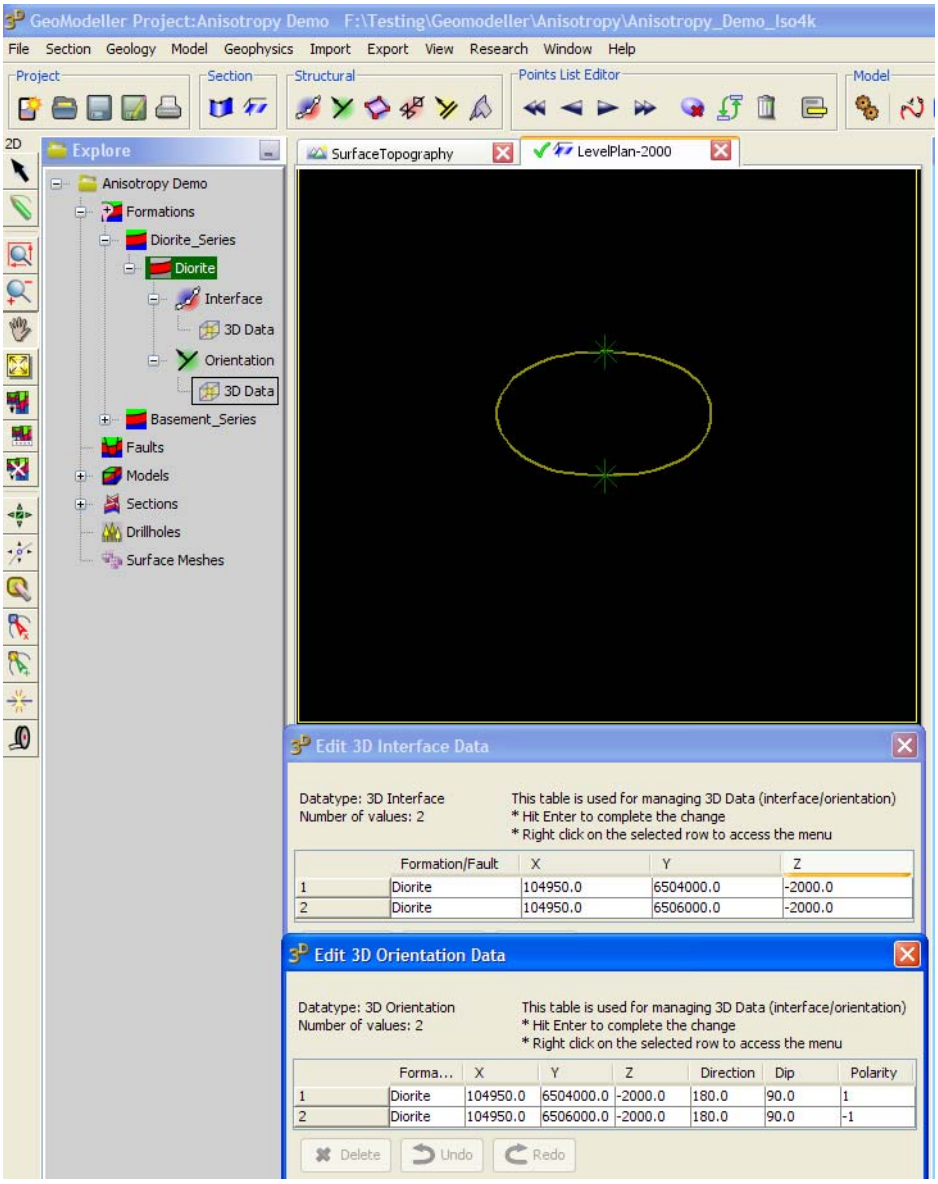
X_Range, **Y_Range** and **Z_Range** are the interpolation range values in metres in the direction of each ellipsoid axis as defined by the three angles above. The range is the distance at which an observation or measurement is no longer spatially correlated with its neighbours and therefore has no further impact on the interpolation.

Interpolation examples—Introduction

Parent topic: **Model interpolation parameters**

The following examples are of a diorite formation with erode properties and a basement. We assigned the diorite only two 3D contact points and two 3D orientation points at the same elevation near the project mid-point. This allows the body geometry to be mostly controlled by the isotropic or anisotropic interpolation parameters.

The two contact points control the width of the Diorite formation in the North direction (~300m).


GeoModeller Project:Anisotropy Demo F:\Testing\Geomodeller\Anisotropy\Anisotropy_Demo_Iso4k
File Section Geology Model Geophysics Import Export View Research Window Help
Project Section Structural Points List Editor Model
Explore
Anisotropy Demo
Formations
Diorite_Series
Diorite
Interface
3D Data
Orientation
3D Data
Basement_Series
Faults
Models
Sections
Drillholes
Surface Meshes
SurfaceTopography
LevelPlan-2000
Edit 3D Interface Data
Datatype: 3D Interface
Number of values: 2
This table is used for managing 3D Data (interface/orientation)
* Hit Enter to complete the change
* Right click on the selected row to access the menu
Formation/Fault X Y Z
1 Diorite 104950.0 6504000.0 -2000.0
2 Diorite 104950.0 6506000.0 -2000.0
Edit 3D Orientation Data
Datatype: 3D Orientation
Number of values: 2
This table is used for managing 3D Data (interface/orientation)
* Hit Enter to complete the change
* Right click on the selected row to access the menu
Forma... X Y Z Direction Dip Polarity
1 Diorite 104950.0 6504000.0 -2000.0 180.0 90.0 1
2 Diorite 104950.0 6506000.0 -2000.0 180.0 90.0 -1
Delete Undo Redo

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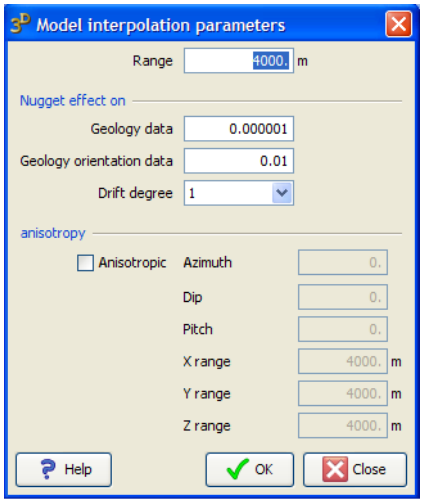
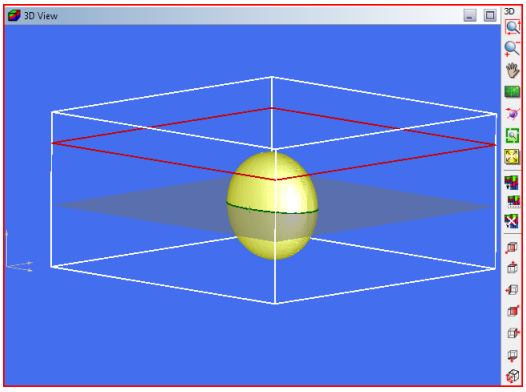
Interpolation example 1—Isotropic

Parent topic: Model interpolation parameters

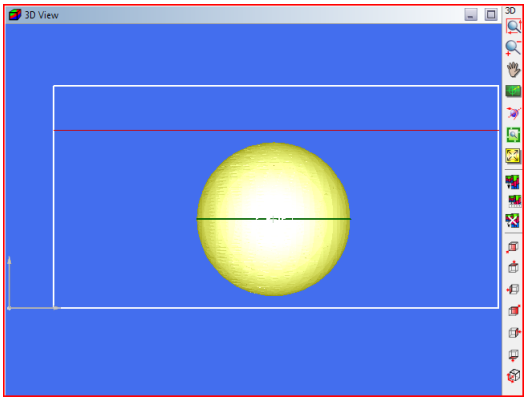
This example shows the use of isotropic settings.



The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west



Front, looking north

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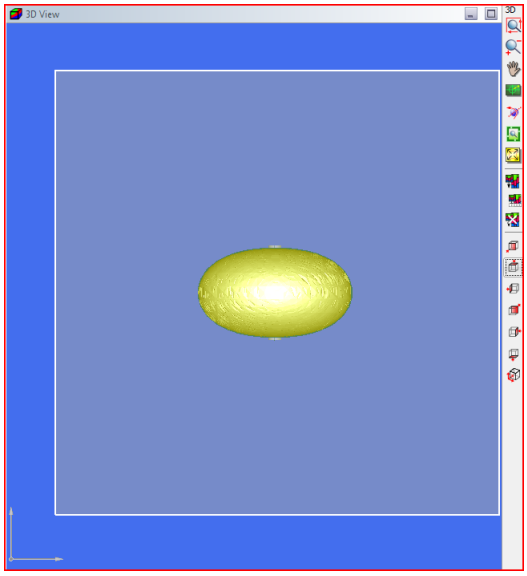
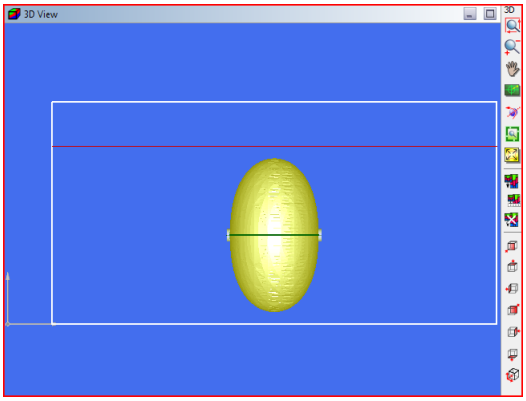


Top, looking down

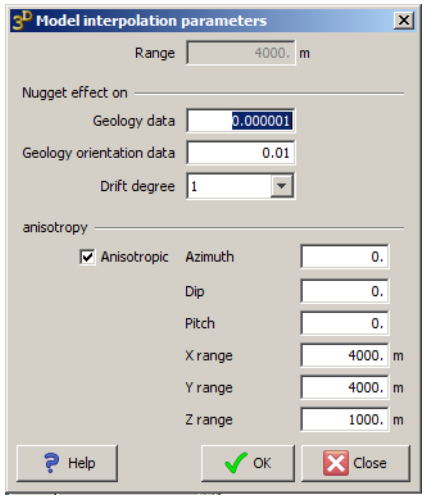


Right, looking west

Interpolation example 2—Anisotropic—No Axes Rotation, Limited Z range

Parent topic: Model interpolation parameters

This example uses anisotropic settings with default angles of zero and limited **Z range**.



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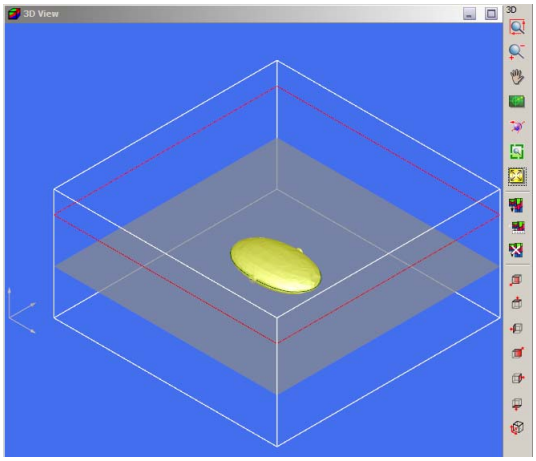
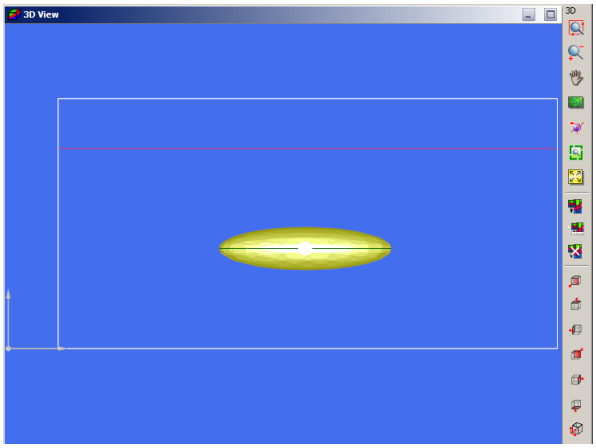
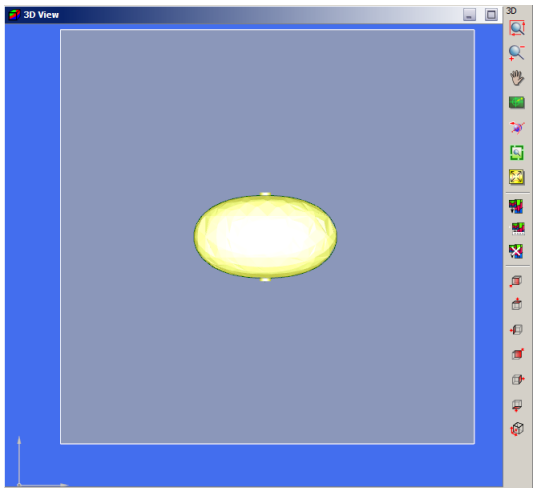
The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west



Front, looking north



Top, looking down

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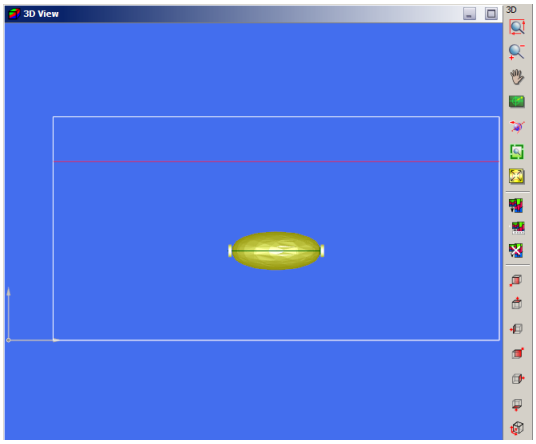
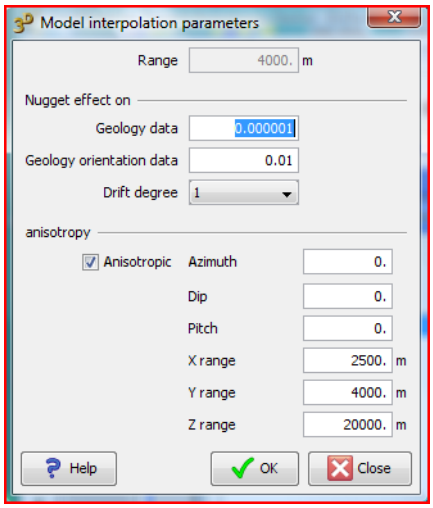


Right, looking west

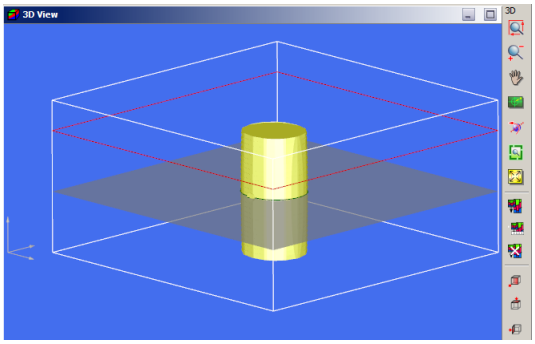
Interpolation example 3—Anisotropic—No Axes Rotation, Large Z Range

Parent topic: Model interpolation parameters

This example has default angles of zero and a greatly expanded **Z range**.



The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west

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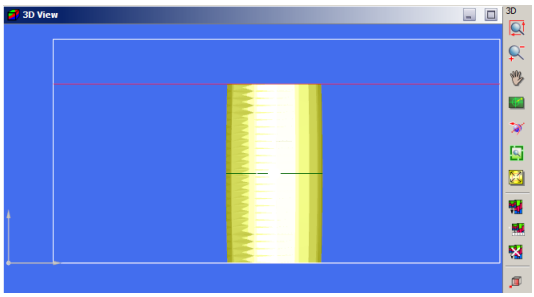
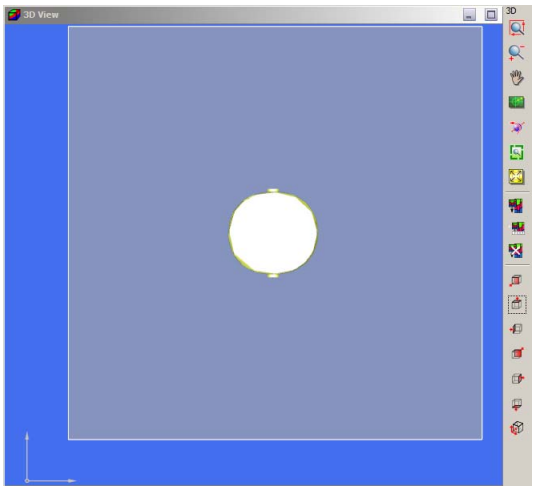
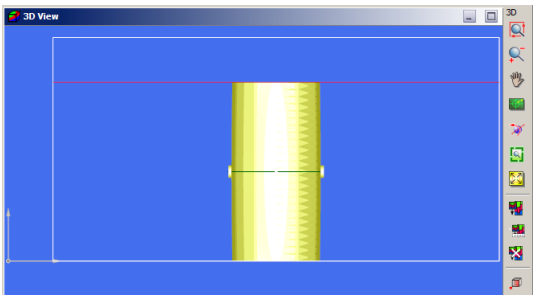


Front, looking north



Top, looking down



Right, looking west

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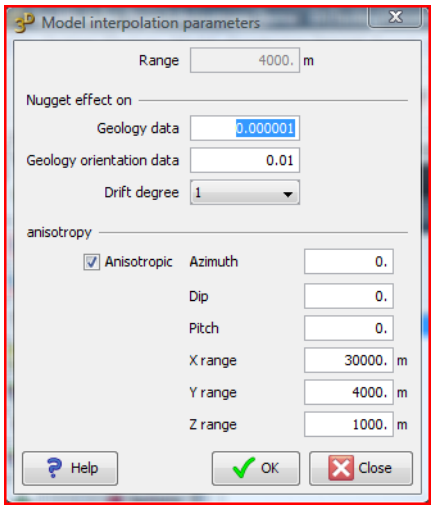
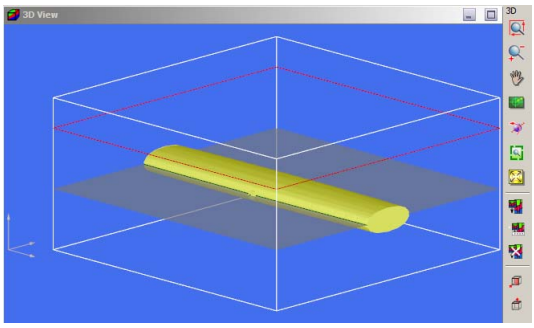
Interpolation example 4—Anisotropic—no Axes Rotation, Large X Range

Parent topic: Model interpolation parameters

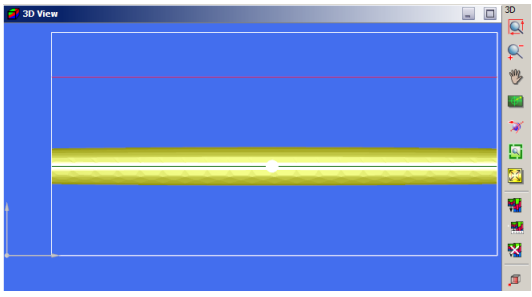
This example has default angles of zero, a greatly expanded the **X range** and a limited **Z range**.



The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west



Front, looking north

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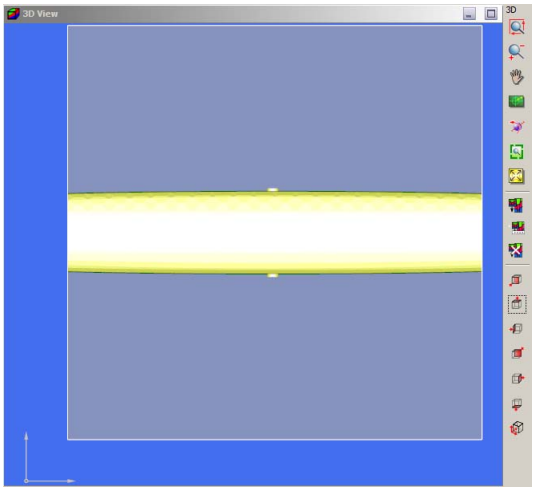
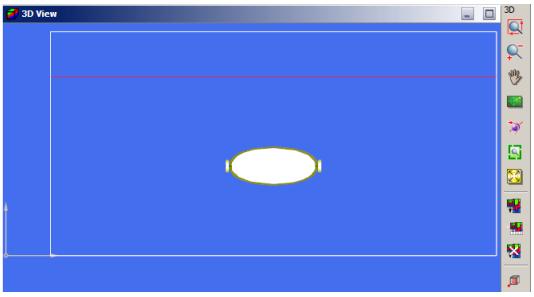


Top, looking down

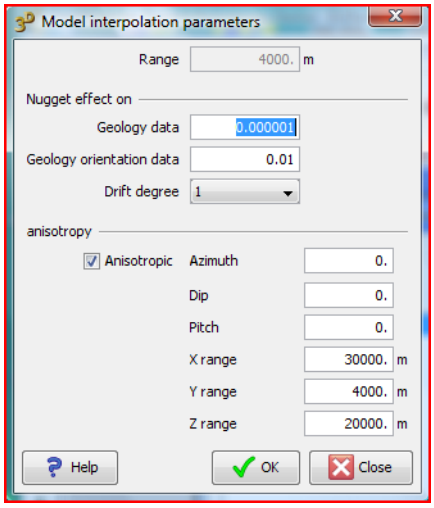


Right, looking west

Interpolation example 5—Anisotropic—No Axes Rotation, Large X & Z Range

Parent topic: Model interpolation parameters

This example has default angles of zero and a greatly expanded the **X range** and **Z range**.



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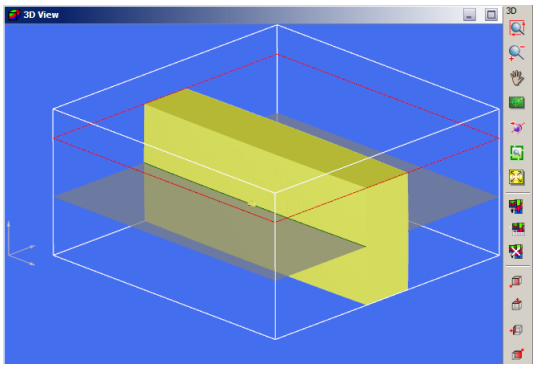
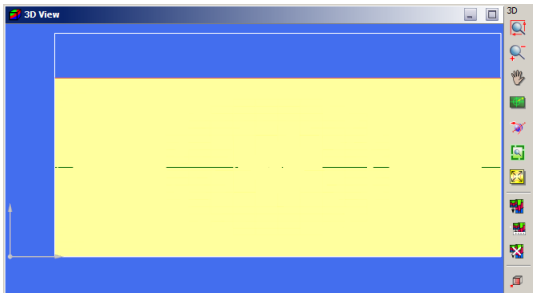
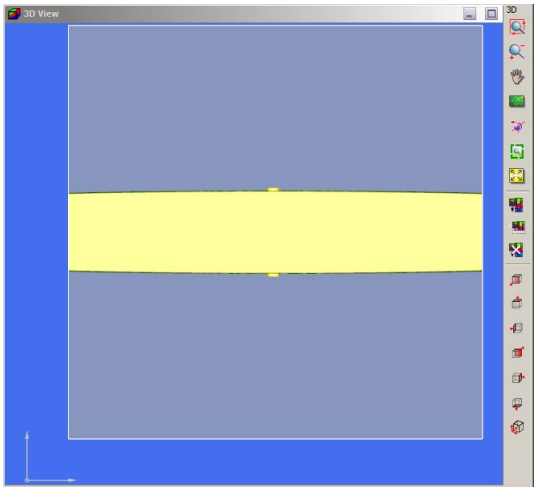
The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west



Front, looking north



Top, looking down

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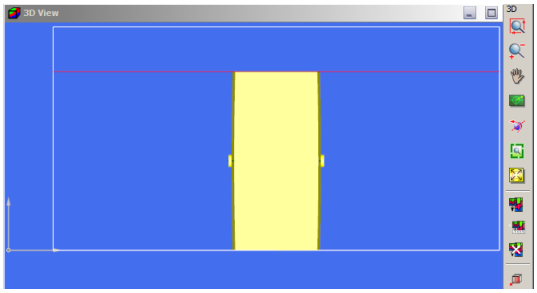
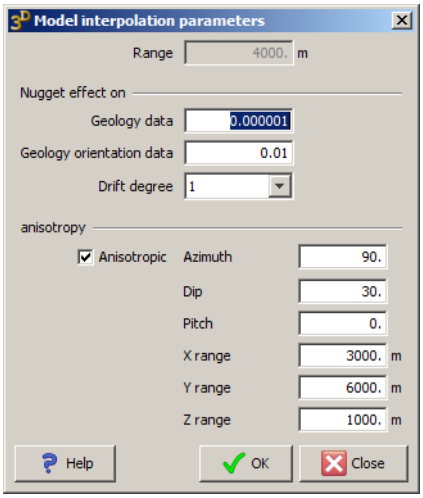


Right, looking west

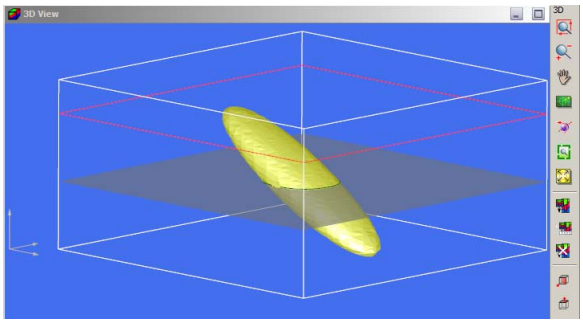
Interpolation example 6—Anisotropic with Azimuth and Dip Rotation

Parent topic: Model interpolation parameters

In this example, the Y axis has a 90° clockwise rotation (**Azimuth**), a 30° **Dip** and a larger Y range (6000 m).



The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west

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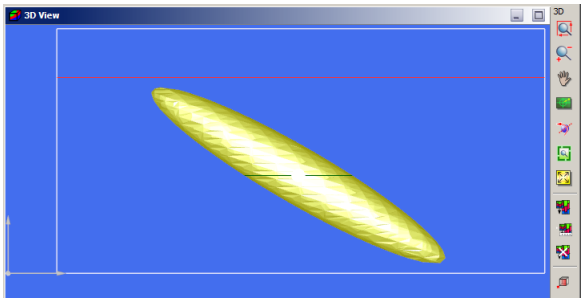
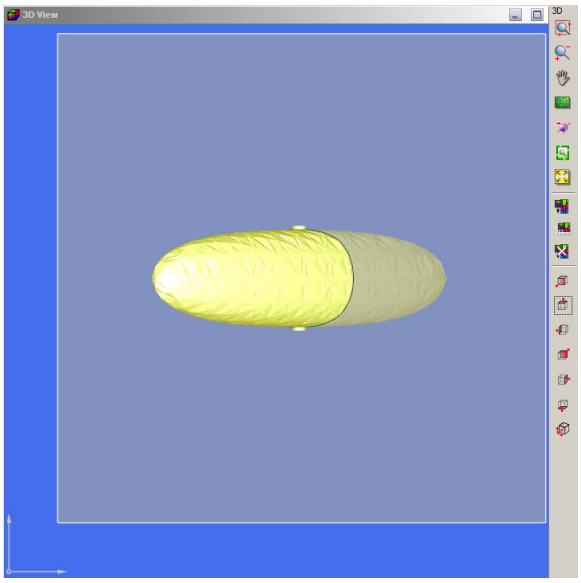
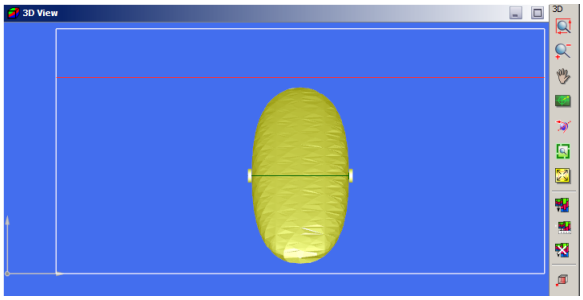


Front, looking north



Top, looking down



Right, looking west

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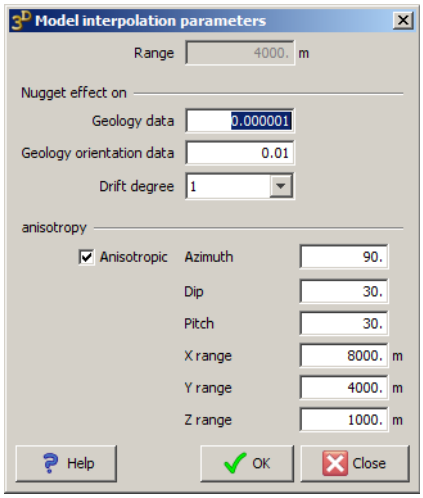
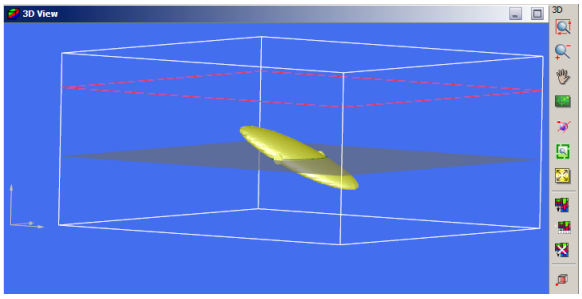
Interpolation example 7—Anisotropic with Azimuth, Dip and Pitch Rotation

Parent topic: Model interpolation parameters

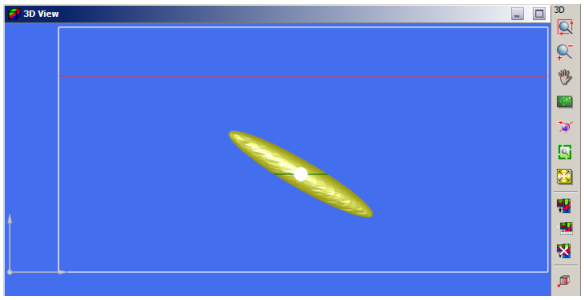
In this example the Y axis has a 90° **Azimuth** and a 30° **Dip**. A **Pitch** rotation of 30° has been added. To visualise the pitch effect it was necessary to increase the **X range** to 8000 m and reduce the **Y range** to 4000 m. If we did not do this, the impact of the east–west strike of the orientation data and the **Y range** would overwhelm the pitch effect.



The following illustrations show the model in 3D perspective (looking north west) and views of the front (looking north), top and right (looking west).



3D axial view north west



Front, looking north

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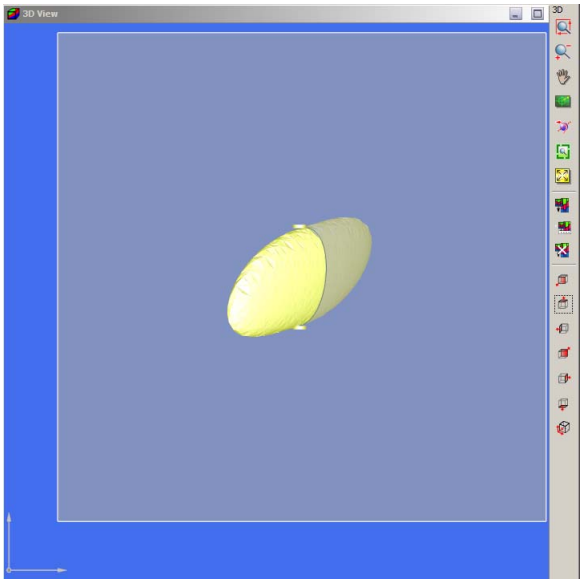
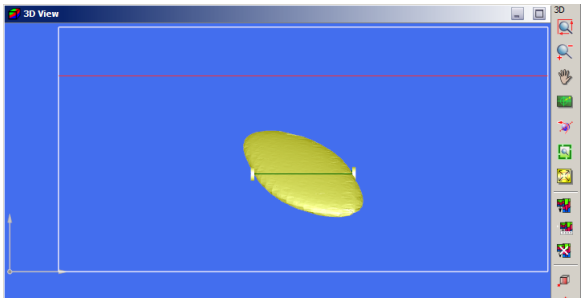


Top, looking down



Right, looking west

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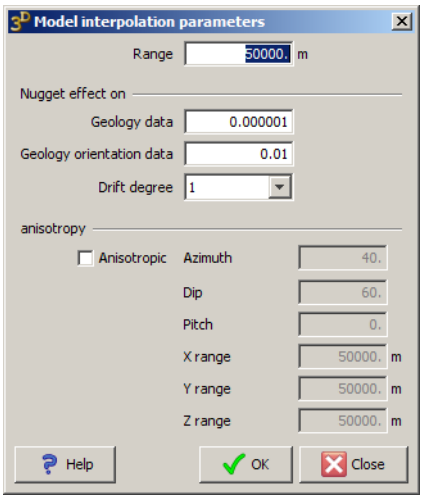
Interpolation example 8—Using Anisotropy to connect widely spaced outcrop data

Parent topic: Model interpolation parameters

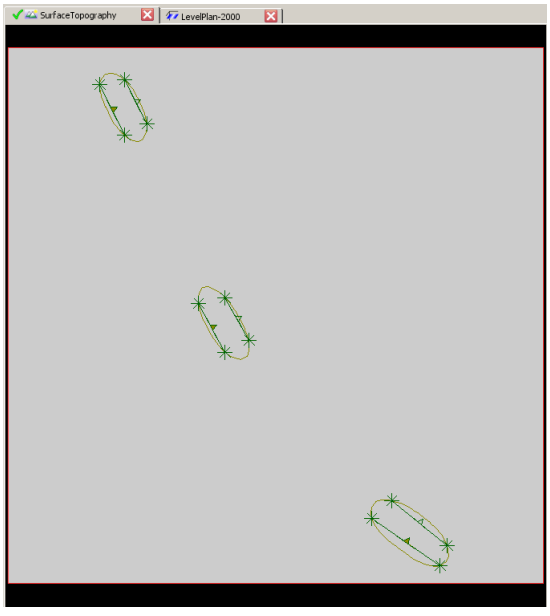
This example shows how you can use anisotropic interpolation to connect three widely separated outcrops of a thin dyke-like body.

Isotropic settings

The first part of the example shows settings for and results of isotropic interpolation of three widely separated outcrops of a thin dyke-like body.



The following illustrations show the resulting isotropic surface plan and the isotropic 3D axial view.



Isotropic surface plan

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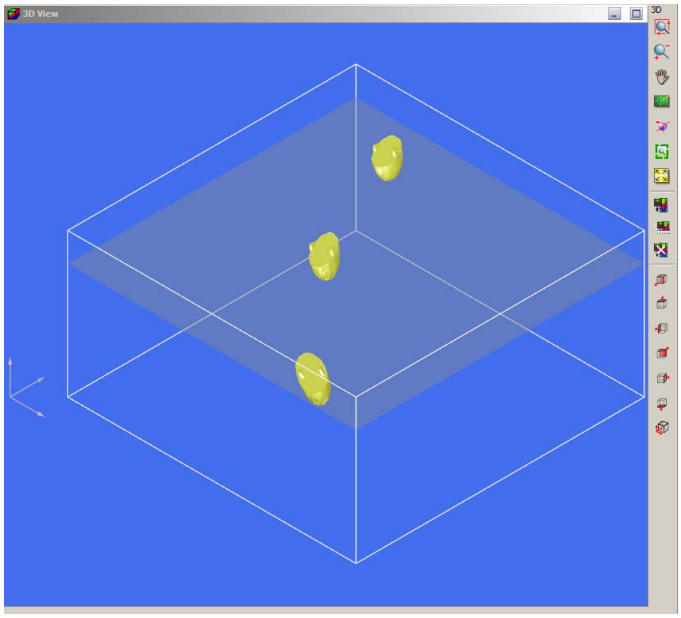
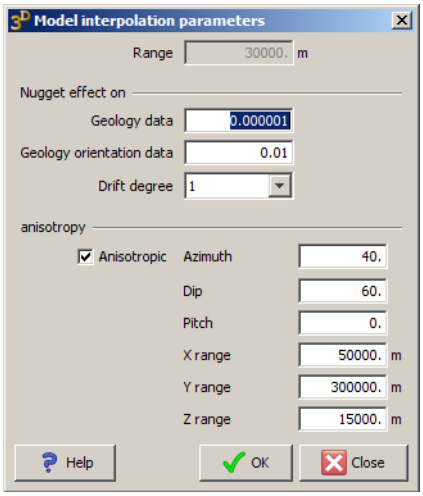


Isotropic 3D axial view north west

Anisotropic settings

The second part of the example shows the settings for and results of anisotropic interpolation of three widely separated outcrops of a thin dyke-like body.



Use of these settings enables the widely separated outcrops to be correlated and connected provided that the chosen anisotropy angles are consistent with the outcrop orientation data.

The Y axis **Azimuth** angle is set to the average dip direction of the dyke outcrops and the **Dip** angle is set to the average **Dip** of the dyke.

The means that the **Y range** is down dip, the **X range** is along strike and the **Z range** is perpendicular to the planar body of the dyke. You need to set the **Y range** to a very large number so that the body extends to the base of the project model. The reason for this is not well understood.

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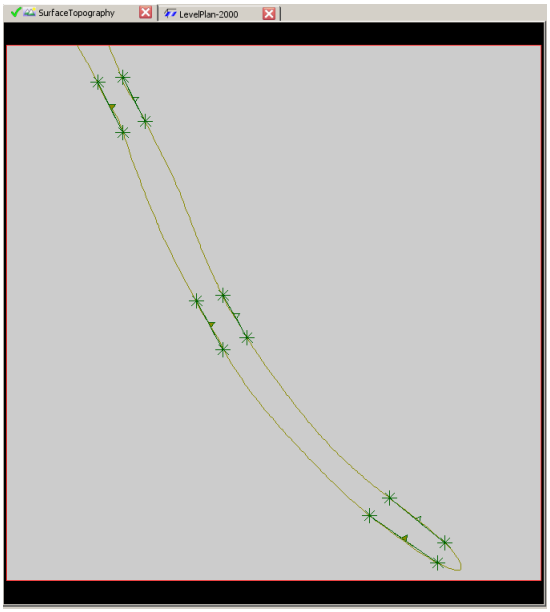
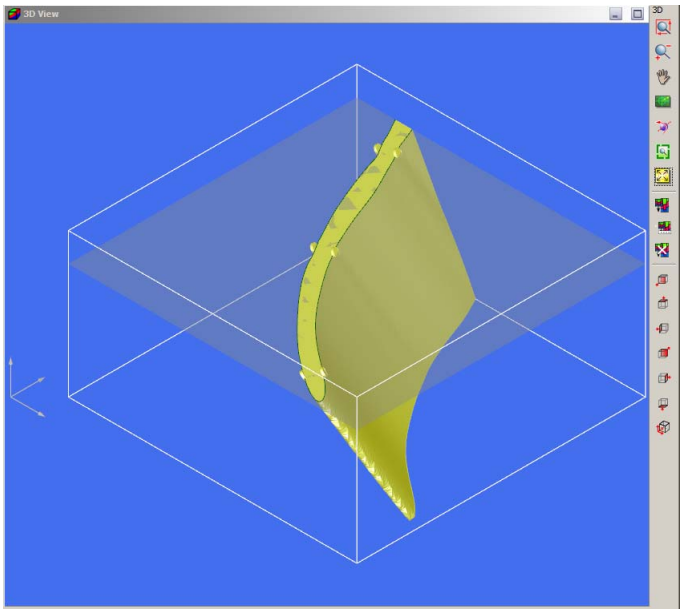


Anisotropic surface plan



Anisotropic 3D axial view (north west)

You can also apply the above strategy to data on widely separated vertical cross sections where only drill hole intersections are available but geophysics indicates continuity.

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Notes about interpolation anisotropy

Parent topic: Model interpolation parameters

Anisotropy is assumed to be constant over the whole project area for the chosen Series. You need to take care when setting these parameters as they can have dramatic results.

Unexpected geometries can occur when you set these parameters and some trial and error is required. It is clear in the example shown above that the range values are much larger than might be expected to obtain the required continuity considering that the project is only 10000 x 10000 x 5000 m.

Anisotropy can be very useful when you are setting up regular shaped synthetic models for testing purposes, for example, evaluating geophysical responses for a variety of geophysical properties and simple geometries.

File formats

Parent topic: 3D GeoModeller Reference

In this section:

- File Formats—Digital terrain model
- File Formats—Images
- File Formats—Structural data
- File Formats—Drillholes
- File Formats—2D and 3D Data Objects

File Formats—Digital terrain model

Parent topic: File formats

You can define topography in a 3D GeoModeller model by importing a grid of digital terrain model (DTM) data. This section describes the available grid file formats that can 3D GeoModeller can read.

Available formats are:

- ERS
- GRD
- TIF
- SEMI
- GDM
- DXF

ERS—ERMapper grid format

This is a standard ERMapper format grid which consists of an ASCII header file (***gridname*.ers**) and a binary file with no extension suffix (***gridname***). The ASCII header file contains the datum and projection, coordinate registration, cell dimensions, numeric format and byte ordering information for the grid.

ERMapper grids are registered by default to the grid cell edges, not to the cell centres. You can define the registration point anywhere inside the grid extents.

GRD—Geosoft grid format

A binary format for storing raster data typically used for geophysical data. Two files describe each grid (suffixes **.grd** and **.grd.gi**). The **.gi** file contains information about the coordinate reference system.

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GRD or ARC ASCIIGRID format

ARC ASCIIGRID refers to a specific interchange format developed for ArcInfo rasters in ASCII format. The format consists of a header that specifies the geographic domain and resolution, followed by the actual grid cell values. Usually the file extension is **.asc**, but recent versions of ESRI software also recognise the extension **.grd**. It looks like this:

```
ncols 157
nrows 171
xllcorner -156.08749650000
yllcorner 18.870890200000
cellsize 0.00833300
0 0 1 1 1 2 3 3 5 6 8 9 12 14 18 21 25 30 35 41 47 53
59 66 73 79 86 92 97 102 106 109 112 113 113 113 111 109 106
103 98 94 89 83 78 72 67 61 56 51 46 41 37 32 29 25 22 19
etc...
```

Coordinates may be in decimal or integer format. DD:MM:SS format for geodetic coordinates is not supported.

xllcorner and **yllcorner** are given as the **edges** of the grid, **not** the centres of the edge cells. ARC INFO supports other header strings that allow the centres of the edge cells to be given using **xllcenter** and **yllcenter** instead. The origin of the grid is the upper left and terminates at the lower right.

ARC format grids are single-band files.

TIF—GeoTIFF grid format (16 bit Integer only)

TIFF is a public domain binary format for storage, transfer, display, and printing of raster images. GeoTIFF refers to TIFF files which have geographic (or cartographic) data embedded as tags within the TIFF file. 3D GeoModeller imports 16 bit GeoTIFF images containing integer terrain heights to create the DTM such as those available for download from some public SRTM sites—CGIAR-CSI. Other GeoTIFF images in 8 bit and 24 bit in which real height values are no longer preserved cannot be imported here.

SRTM GeoTIFF images are registered to the top left corner (Edge) of the image which is the top left corner of the first cell (TIFF tag is **PixelIsArea**). This is equivalent to the registration system used by ERMapper.

SEMI—ASCII grid format

The SEMI format is an ASCII file. The first line of a SEMI file has the following format:

```
W XMIN=<real> YMIN=<real> XMAX=<real> YMAX=<real>
NUMBERX=<integer> NUMBERY=<integer>
```

With the information in this line it is possible to build a 2D table of real coordinates coded on 8 bytes.

The remainder of the file contains the data for each point of the grid. The data for each grid node are recorded on a separate line as follows:

```
<real> <real> <real>
```

The three real values for each line represent respectively the East (X) coordinate, the North (Y) coordinate and the elevation value.

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GDM—BRGM grid format

GDM is in-house BRGM software used for drillhole data management. The software includes a binary file format for the representation of grid data. For detailed information on this format, refer to the GDM Reference Manual or contact GDM technical support.

DXF—AutoCAD ASCII vector format

The ASCII version of the DXF vector drawing format created by Autodesk for interoperability between AutoCAD and other software can be used as a DEM source for a 3D GeoModeller project. The primitives supported include 3D faces and 3D polylines or points. The 3D data is extracted from the DXF file and gridded prior to import to 3D GeoModeller.

File Formats—Images

Parent topic: File formats

The 3D GeoModeller **Image Manager** can load images onto sections in the following image file formats:

- BMP
- GIF
- JPG
- PNG
- TIF (only 8 bit and 24 bit, not 16 bit)

For more information about loading images on sections in 3D GeoModeller, see:

- Image Manager dialog box
- Edit and Align Image dialog box

File Formats—Structural data

Parent topic: File formats

The format for storage of structural data enables the exchange of data between several 3D GeoModeller projects.

It is an ASCII file, and contains structural data organised in the following manner:

```
----------------------------------------------------Start of file
<integer> INTERFACES
    INTERFACE <string> <string>
    <integer> POINTS
        <real> <real>
        ...
        <integer> ASSOCIATEDORIENTATIONS
            <real> <real> <real> <real> <integer> <string>
            ...
    ...
<integer> FOLIATIONS
    <real> <real> <real> <real> <integer> <string>
    ...
----------------------------------------------------End of file
```

Description

The following sections describe this format.

<*integer*> INTERFACES

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Total number of different geology horizons or 'interfaces' for which geology data are defined (includes geology contacts, and faults). An integer number, followed by the keyword **INTERFACES**

INTERFACE <*string*> <*string*>

The keyword **INTERFACE**, followed by the names of the 2 geology formations on either side of this interface (geology contact, ... or fault). The geology data which follow are associated with the **second** named of the two formations.

<*integer*> POINTS

Total number of points in the following list of geology data points

<*real*> <*real*>

For each point of the list of geology data:

- East (x) coordinate
- North (y) coordinate

<*integer*> ASSOCIATEDORIENTATIONS

Total number of 'associated' geology orientation data in the following list of points. These are geology orientation data which are 'associated' with the preceding list of geology data points

<*real*> <*real*> <*real*> <*real*> <*integer*> <*string*>

For each 'associated' geology orientation data point

- East (x) coordinate
- North (y) coordinate
- Dip direction, between 0 and 360)
- Dip (between –90 and +90)
- Polarity (normal = 1 or reverse = –1)
- Name of the 'associated' geology formation

<*integer*> FOLIATIONS

Total number of geology orientation data points

<*real*> <*real*> <*real*> <*real*> <*integer*> <*string*>

For each geology orientation data point:

- East (x) coordinate
- North (y) coordinate
- Dip direction, between 0 and 360)
- Dip (between –90 and +90)
- Polarity (normal = 1 or reverse = –1)
- Name of the 'associated' geology formation

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Example file (To make this example easier to read we truncated the real numbers, removing the decimals):

```
----------------------------------------------start of file
2 INTERFACES
    INTERFACE Secondary Socle
    5 POINTS
         2608. 711.
         3007. 757.
         3321. 815.
         3356. 967.
         3461. 963.
         4 ASSOCIATEDORIENTATIONS
             2808. 734. 228. 6. 1 Socle
             3164. 786. 228. 10. 1 Socle
             3338. 891. 228. 77. 1 Socle
             3408. 965. 48. 2. 1 Socle
     INTERFACE Tertiary Socle
    3 POINTS
         3959. 1209.
         4357. 1404.
         5022. 1699.
4 FOLIATIONS
 294833. 2277538. 10. 55. 1 Secondary
 295042. 2278478. 10. 55. 1 Secondary
 288625. 2283317. 4. 85. -1 Quaternary
 280990. 2283270. 352. 85. -1 Tertiary
------------------------------------------------------end file
```

Notes

- To load structural data into 3D GeoModeller, the data must observe this format specification.
- The coordinates must be the (u, v) coordinates of the 2D space of the relevant map or the section.
- With regard to the geology orientation data, the values for dip direction and dip follow Hoeke's convention.
- To define a block which contains no data, use 0. For example:
  `0 ASSOCIATEDORIENTATIONS`

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File Formats—Drillholes

Parent topic: File formats

3D GeoModeller can use drillhole data imported as either ASCII files or in the BRGM's GDM file format.

ASCII Format

A file containing drillhole data is organised in the following way. Each line of the file contains the data defining a 'geology interval' in the drillhole.

```
-------------------------------------------------Start of file
<String> <real> <real> <real> <real> <String>
...
-------------------------------------------------End of file
```

These fields represent:

- Name of drillhole
- East (X) coordinate of the drillhole collar
- North (Y) coordinate of the drillhole collar
- Height of the drillhole collar
- Depth to the end of the geology interval
- Name of the geology formation for this drilled interval

Example file (To make this example easier to read we truncated the real numbers, removing the decimals):

```
-----------------------------------------------Start of file
S080   997540.   167670.   220.   105.   Quaternary
S080   997540.   167670.   220.   123.   Tertiary
S080   997540.   167670.   220.   278.   Secondary
S080   997540.   167670.   220.   569.   Socle
S081   997054.   172524.   139.     62.   Quaternary
S081   997054.   172524.   139.   307.   Secondary
S083   996100.   159765.    -46.   281.   Tertiary
-----------------------------------------------End of file
```

For drillhole S080, the Quaternary formation interval extends from depth 0 to 105. For drillhole S080, the Secondary formation interval extends from depth 123 to 278. The collar of drillhole S083 is located below sea level, at an altitude of –46.

Format GDM

GDM is in-house BRGM software used for drillhole data management. The software enables the export of drillhole data in a proprietary (binary) format.

For detailed information on this format, refer to the *GDM Reference Manual* or contact GDM technical support.

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File Formats—2D and 3D Data Objects

Parent topic: File formats

The main difference between the 2D and 3D data objects is not so much about the data, but rather the way in which these are used in 3D GeoModeller.

The loading and export of both 2D and 3D data objects share the same low level file reading and writing routines. The decision to use or not use the third dimension is made only at the execution time.

The available formats are as follows:

- DXF 12 and 13
- IGES
- STEP
- VRML 10 and 20
- BRep

DXF Format (Data eXchange Format)

The DXF format is very popular in the world of geographical information systems (GIS) and CAD.

It is a proprietary format published by AUTODESK, creator of the popular CAD/CAM software AUTOCAD.

DXF is an ASCII file format.

A detailed description of this format can be found in the AUTOCAD reference manual *Drawing Interchange and File Formats*.

IGES Format (Initial Graphic Exchange Specification)

The IGES format is an ANSI standard intended for the data exchange of manufactured objects.

The following URL-links have a complete description of this format:

http://www.nist.gov/iges/

http://www.iges5x.org/

STEP Format (Product Data Representation and Exchange)

The STEP format is an ISO standard (ISO 13003) intended for the data exchange of manufactured objects.

VRML Format (Virtual Reality Modelling Language)

The VRML format, initially developed by Silicon Graphics, is a popular ASCII format used in animation and virtual reality work.

Its most recent version is now an ISO standard (ISO/IEC14772-1:1997).

The following site has a complete description of this format:

http://www.vrml.org/

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BRep Format (Boundary Representation)

The BRep format is an ASCII file, and is a proprietary format of MATRA Datavision

This format, particularly effective for the storage of geometrical objects designed by CSG methods (Constructive Solid Geometry), and is available across the entire range of Quantum products developed by MATRA Datavision (EUCLID, etc.).

This is a native format used in CASCADE, the library of 2D/3D tools used for the development of 3D GeoModeller.

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2D and 3D Meshes and Grids In 3D GeoModeller

Parent topic: 3D GeoModeller Reference

In this section:

- Introduction to 2D and 3D meshes
- Mesh Grid Concepts and Types
  - The mesh types managed in Geomodeller:
  - Grid primitives managed in Geomodeller:
  - Grid types in 2D or 3D:
  - Mesh and Grid Topological Structure
  - Mesh and Grid Examples & Application Flow Chart
  - Mesh and Grid element/field datatypes implemented in mesh grid objects:

Introduction to 2D and 3D meshes

Parent topic: 2D and 3D Meshes and Grids In 3D GeoModeller

The purpose of Meshes and Grids in 3D GeoModeller is to provide 2D and 3D objects for storing, querying, manipulating and visualising raw input data and the products derived from them by interpolation and geophysical forward modelling and inversion. They are also used for storing raw and processed 2D and 3D data of similar types imported from external sources/other software packages. These external data sets can be used as inputs or references for these same internal functions.

- Input data types stored in these objects include:
  - drillhole assays
  - drillhole geophysical logs
  - 2D observations (surface, airborne - geochemical, geophysical)
  - 3D observations (terrain, seismic picks, depth to basement)
  - 2D grids (geophysics, geochemistry, elevations, isopachs)
  - 3D grids (geological and geophysical voxets from other software (GoCAD)
- Outputs from the internal processing functions listed and stored in these objects include:
  - Interpolation by Inverse Distance, Classical and Domain Kriging
    - 2D grids of geophysics and geochemistry
    - 3D grids of assays or rock properties (density and susceptibility)
  - 3D Geophysical forward modelling and inversion
    - 2D geophysical grids
    - 3D geological and geophysical property voxets
  - 3D geological model outputs from GeoModeller's Cokriging interpolator
    - 2D surface meshes (triangulations)
    - 3D meshes (triangulations) and 3D voxets of geology, potential and gradient

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Mesh Grid Concepts and Types

Parent topic: 2D and 3D Meshes and Grids In 3D GeoModeller

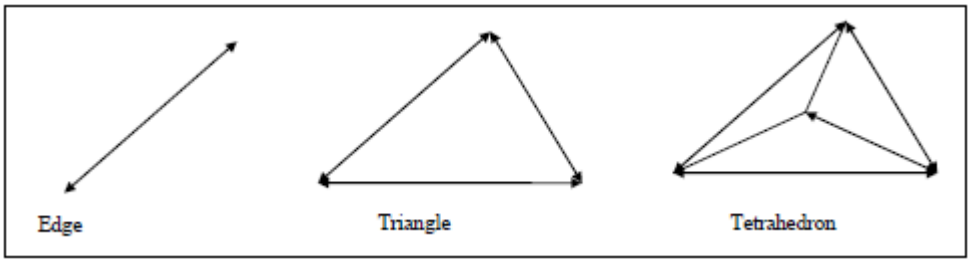
The mesh types managed in Geomodeller:

- Vertices (2D/3D)
- Triangles (2D/3D)
- Tetrahedrons (3D)

Vertices (2D/3D): A Mesh of vertices (in 2D or 3D) is a mesh of points (2D {x, y} and 3D {x, y, z}) This type of mesh is used to store and manipulate observations/measured points. There is no link between the points.

Triangles: A Mesh of triangles (in 2D and 3D) is a mesh built using triangles sharing the vertices. This type of mesh is used to represent the boundary of a unit in 3D for visualisation purposes.

Tetrahedrons: Meshes of tetrahedrons (3D only) are meshes to describe the lithology units as solid objects. We will add properties/values to some elements of this mesh (vertices/tetrahedrons) using interpolation techniques (inverse distance, kriging) .

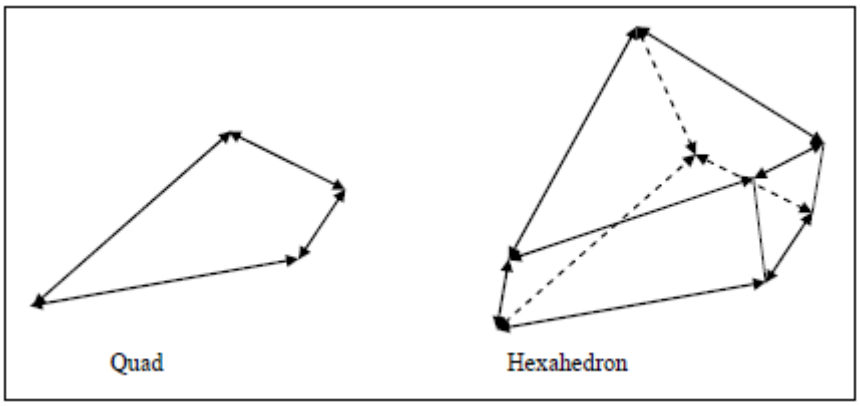


Grid primitives managed in Geomodeller:

- Quadrangles (2D)
- Hexahedrons (3D)

Quadrangles (2D: These grids are used to represent 2D fields, or intersections of a 3D grid with a 2D surface.

Hexahedrons (3D): These grids are used to represent 3D fields. The unique regular hexahedron is the cube. This is the most common element in GeoModeller 3D grids.



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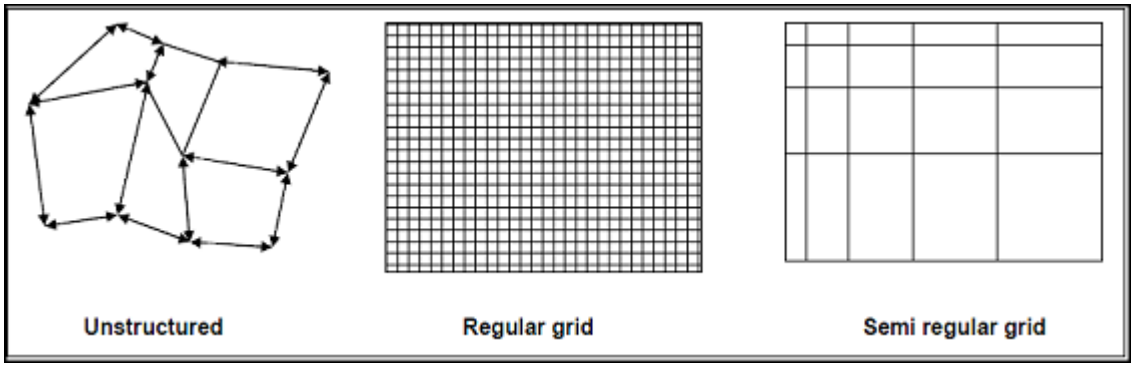
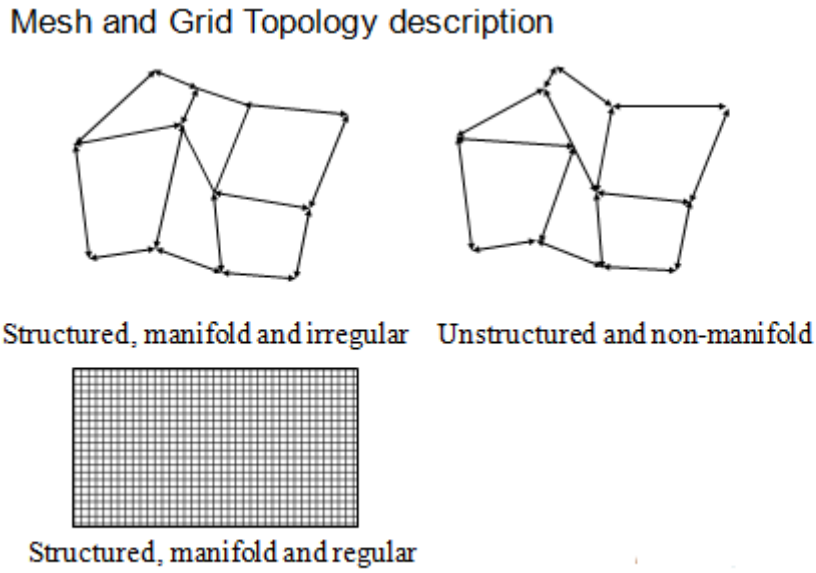
Grid types in 2D or 3D:

- Regular grids
- Semi-Regular grids
- Non regular, unstructured grids



Mesh and Grid Topological Structure


Mesh and Grid Topology description
Structured, manifold and irregular
Unstructured and non-manifold
Structured, manifold and regular

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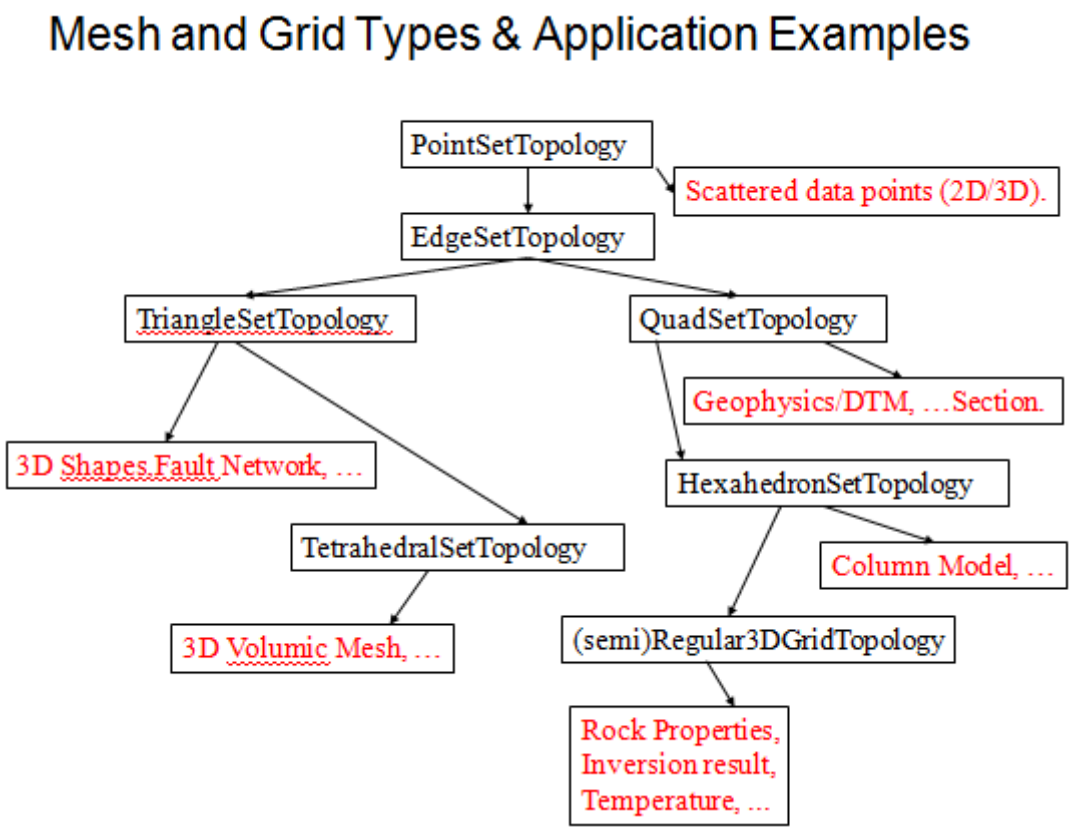
Mesh and Grid Examples & Application Flow Chart



Mesh and Grid element/field datatypes implemented in mesh grid objects:

- Integer
- Real
- Boolean
- String

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Mesh Grid Operations

Parent topic: 3D GeoModeller Reference

In this section:

- From Explore Context Menu: Drillhole fields to data points mesh
- From Explore 3D Geology Context Menu: Create 2D/3D Grids from Model
- From Explore 3D Geology Context Menu: Create 3D Grids with Physical Properties
- From Meshes and Grids Context Menu
- From Individual Mesh Grid Context Menu
- From Mesh and Grid Fields Context Menu

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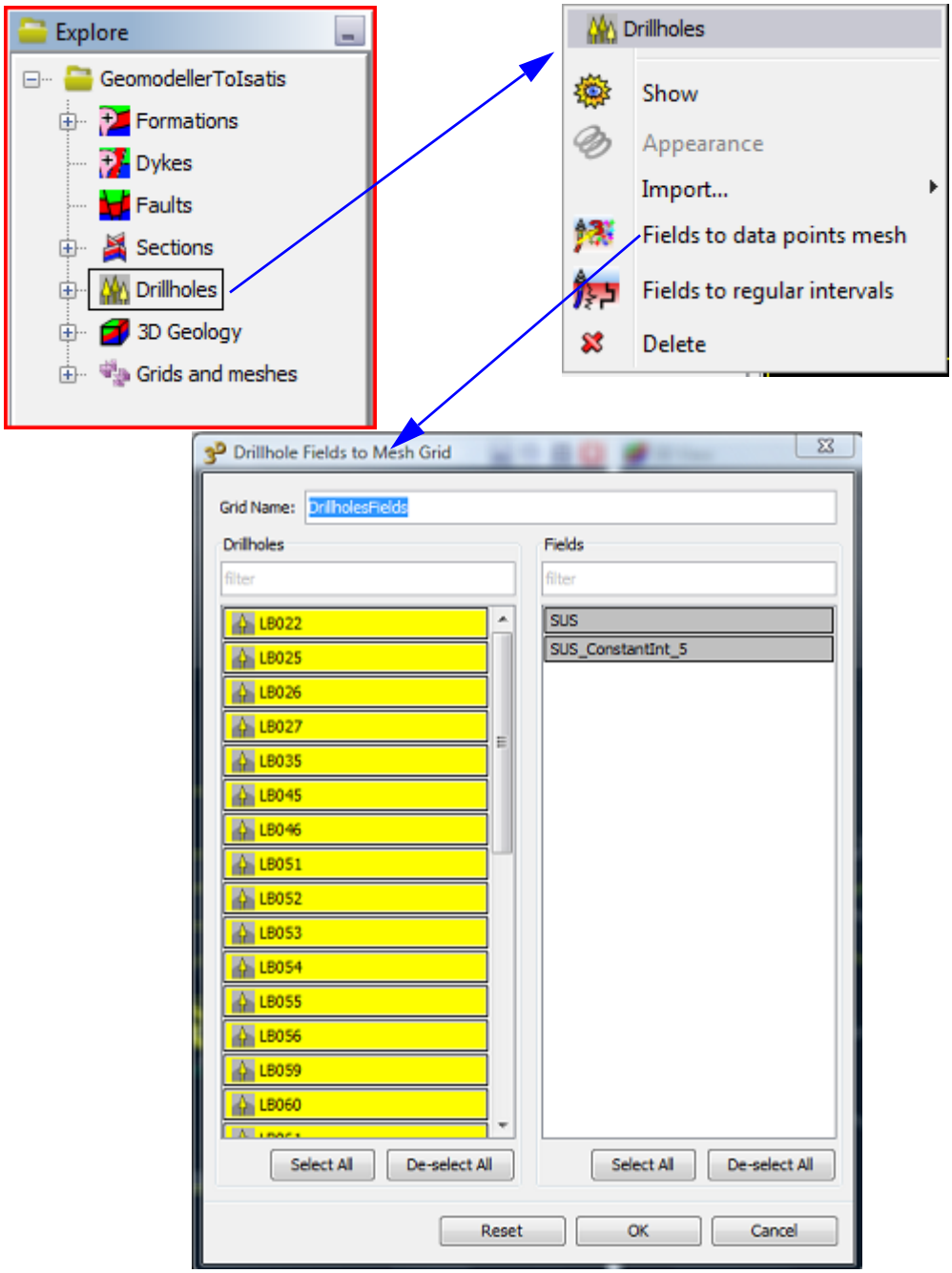
From Explore Context Menu: Drillhole fields to data points mesh

Parent topic: Mesh Grid Operations

Select the drillholes and fields to copy to the data points mesh. The x, y, z coordinate of the mid point of each field's from/to interval and the field value will be copied to a mesh vertex. Not all vertices will be populated with every field value (some may be null). This occurs if both the original value and the regularised value are copied to the same mesh or not all fields contain measurements for each from/to interval (density and susceptibility logs).



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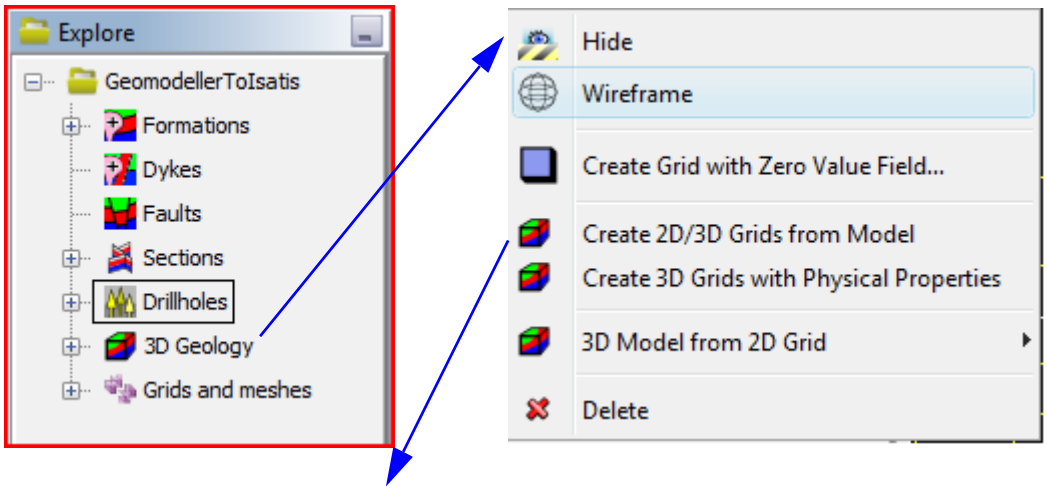
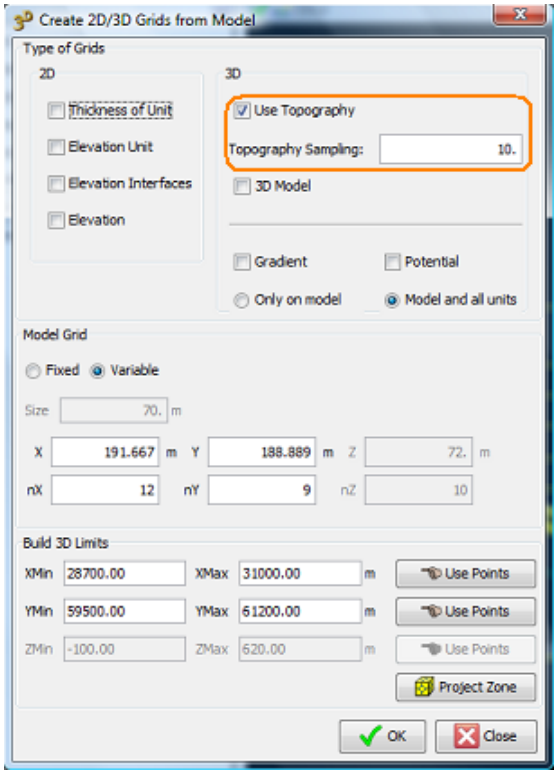
From Explore 3D Geology Context Menu: Create 2D/3D Grids from Model

Parent topic: Mesh Grid Operations

Build meshes and grids from your 3D Model

- **2D** - Toggle one or more of the options in the left hand panel
  - **Thickness of Unit** (Isopach) **Note: Unit = formation**
  - **Elevation of Unit** (Isohypse)
  - **Elevation Interfaces** (Only where formation interface is defined)
  - **Elevation** of the topographic surface (Project DTM) OR
- **3D** - Toggle one or more of the options in the right hand panel
  - **3D Model**
  - **Gradient** - model gradients calculated by the implicit function
  - **Potential** - model potential calculated by the implicit function
    - Choose **Only on model** or **Model and all units** for gradients and potential





- **3D** - The **Use Topography** option and the **Topography sampling** value in the upper right panel (red) allow the user to create a semi-regular voxet where a smaller voxel Z dimension can be specified for the voxet between the minimum and maximum elevation height.

Note: If the user creates a lithology model voxet for input to inversion then the voxet must be regular with a uniform voxel Z dimension.

- **Model Grid** - Choose the cell resolution or number of cells in X,Y,Z
- **Buld 3D Limits** - Choose the extents of the voxet model in the lower panel. You can **Use Points** in the points editor to set the grid extents.

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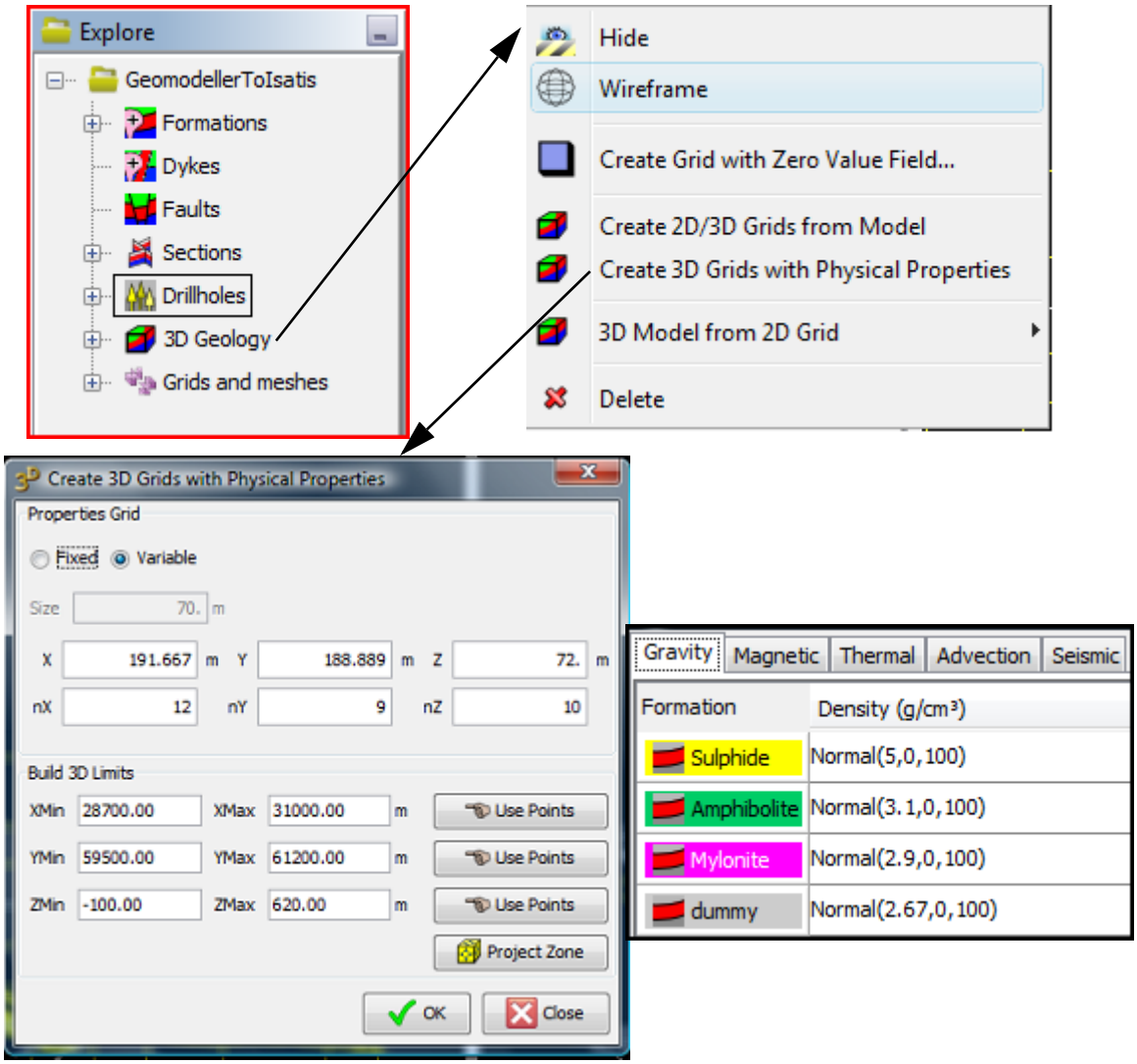
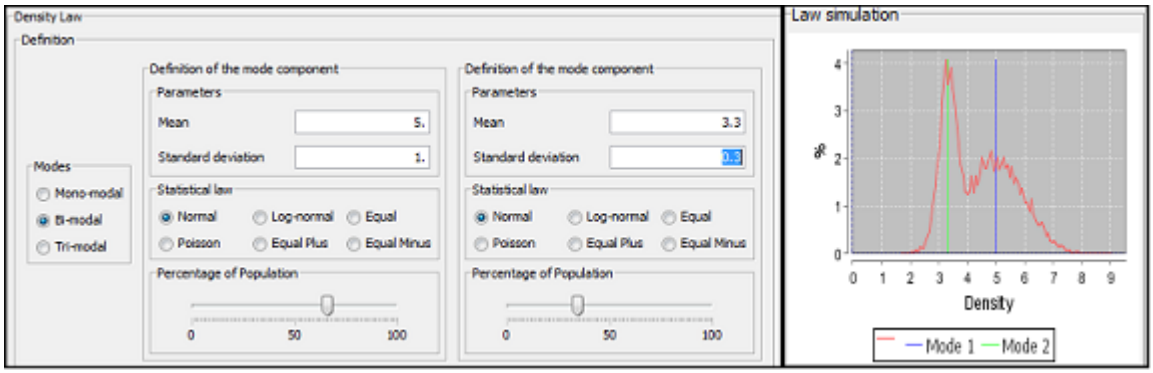
From Explore 3D Geology Context Menu: Create 3D Grids with Physical Properties

Parent topic: Mesh Grid Operations

This function creates a single mesh grid with 5 property fields; Density, Susceptibility, Thermal Conductivity, Heat Production Rate and Seismic Velocity.



The mesh grid is created from the current computed model pile and is randomly initialised using the geophysical properties and statistical distribution defined for each formation, (Mode: Mono/Bi/Tri-Modal; Population Mean, Standard deviation and Statistical law: Normal, Log normal, ...)



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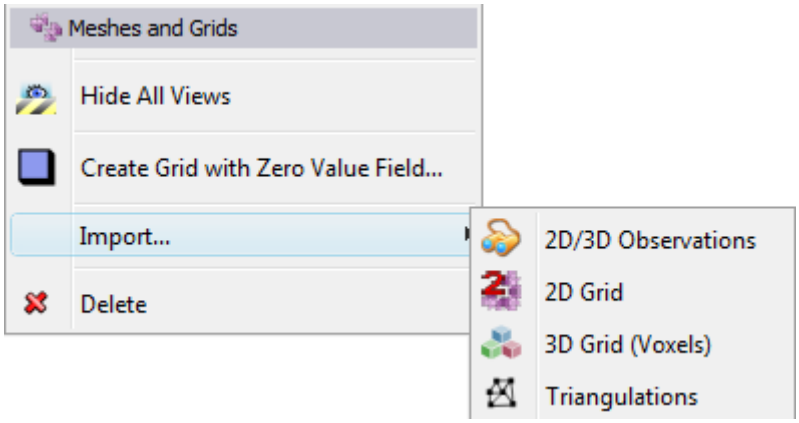
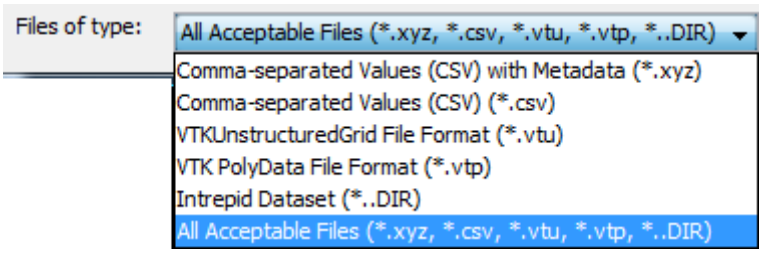
From Meshes and Grids Context Menu

Parent topic: Mesh Grid Operations

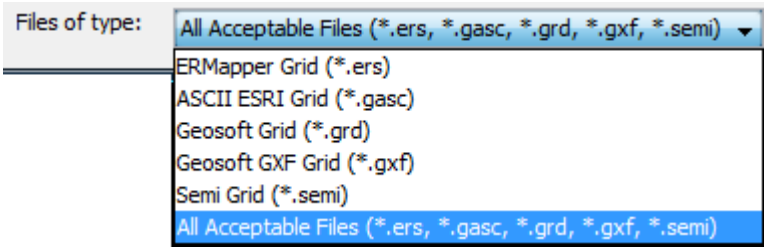
Right clicking on the **Meshes and Grids** menu in the **Explore** tree produces the following dialog of choices



- **Hide All Views**
  - Clears from view any meshes or grids displayed in the 2D or 3D viewers
- **Create Grid with Zero Value Field**
  - creates a 2D grid at the resolution defined and fills it with zero's. Useful as a starting point for a new computation.
- **Import**
  - Import external or internal meshes and grids in a variety of formats. Supported formats are fully documented in the **Import** section of the manual
    - **2D/3D Observations**


Files of type:
All Acceptable Files (*.xyz, *.csv, *.vtu, *.vtp, *..DIR)
Comma-separated Values (CSV) with Metadata (*.xyz)
Comma-separated Values (CSV) (*.csv)
VTKUnstructuredGrid File Format (*.vtu)
VTK PolyData File Format (*.vtp)
Intrepid Dataset (*..DIR)
All Acceptable Files (*.xyz, *.csv, *.vtu, *.vtp, *..DIR)

    - **2D Grid**


Files of type:
All Acceptable Files (*.ers, *.gasc, *.grd, *.gxf, *.semi)
ERMapper Grid (*.ers)
ASCII ESRI Grid (*.gasc)
Geosoft Grid (*.grd)
Geosoft GXF Grid (*.gxf)
Semi Grid (*.semi)
All Acceptable Files (*.ers, *.gasc, *.grd, *.gxf, *.semi)

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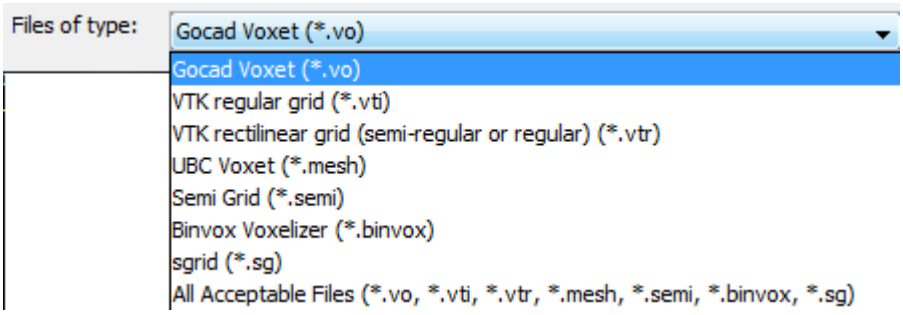
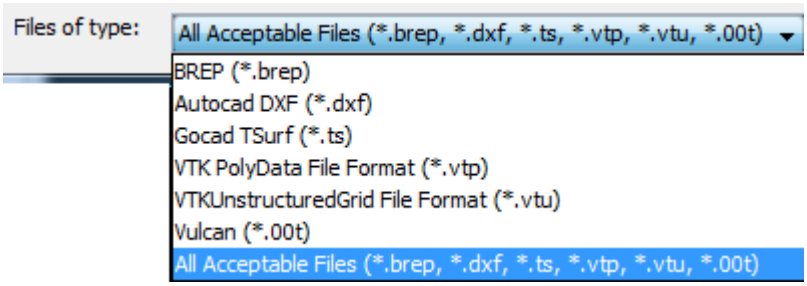
- **3D Grid (Voxels)**


Files of type:
Gocad Voxet (*.vo)
Gocad Voxet (*.vo)
VTK regular grid (*.vti)
VTK rectilinear grid (semi-regular or regular) (*.vtr)
UBC Voxet (*.mesh)
Semi Grid (*.semi)
Binvox Voxelizer (*.binvox)
sgrid (*.sg)
All Acceptable Files (*.vo, *.vti, *.vtr, *.mesh, *.semi, *.binvox, *.sg)

- **Triangulations**


Files of type:
All Acceptable Files (*.brep, *.dxf, *.ts, *.vtp, *.vtu, *.00t)
BREP (*.brep)
Autocad DXF (*.dxf)
Gocad TSurf (*.ts)
VTK PolyData File Format (*.vtp)
VTKUnstructuredGrid File Format (*.vtu)
Vulcan (*.00t)
All Acceptable Files (*.brep, *.dxf, *.ts, *.vtp, *.vtu, *.00t)

- **Delete**
  - Deletes all mesh grids from the 3D GeoModeller project

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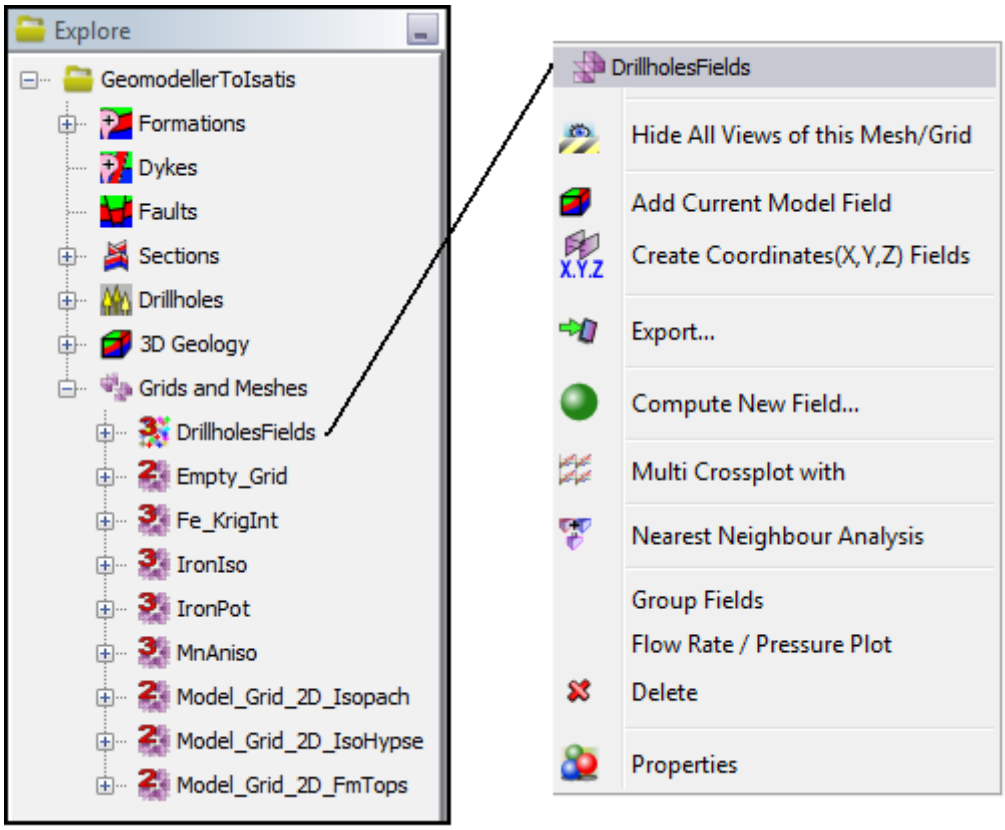
From Individual Mesh Grid Context Menu

Parent topic: Mesh Grid Operations

An Irregular Vertex Mesh or Point Cloud

Right clicking on an individual mesh grid in the **Explore** tree produces the following dialog of choices for the DrillHoleFields irregular vertex mesh



- **Hide All Views of this Mesh/Grid**
  - Clears from view any field of the current Mesh or Grid displayed in the 2D or 3D viewers.
- **Add Current Model Field**
  - Adds an integer field for each formation (lithology) in the current model pile to the current mesh or grid. Each formation (lithology) is assigned an integer starting from 1 at the base of the pile and increasing upwards.
  - The formations are sampled at the mesh vertices or grid cell/voxel centroids depending on the type.
  - If present, an Above_Topo formation is always assigned the value 0. It represents that part of the grid from the top of the topographic surface to the top of the 3D voxet. This formation is only present in 3D voxets created during geophysical forward modelling and inversion and is not part of the model pile.
  - The lithology field is a special type which is recognised by setting an Alias named Lithology. This allows the mesh or voxet field to be automatically recognised as such and to be assigned the current formation colours when displayed in the 2D or 3D viewers.
  - It also allows the histogram tool to report volumes for each formation since conventional statistics are meaningless in this context.

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- **Create Coordinates(X, Y, Z) Fields**
  - Adds the X,Y,Z coordinates of each vertex, cell or voxel to the current Mesh or Grid as 3 separate fields. These may be useful for calculations in the MeshGrid calculator or for export for use in other applications.
- **Export**
  - Export the selected mesh or grid to one of the supported export formats. The user chooses the output directory, format and filename. The available formats are sensitive to the mesh grid type as shown in the list and dialogs below.
    - 3D observations
      - CSV
      - VTKUnstructuredGrid file format
    - 2D grids
      - ERMapper
      - ASCII ESRI
      - Geosoft grd
      - Geosoft gxf
      - Semi
      - VTK regular
    - 3D grids
      - GoCAD Voxet
      - CSV Voxet
      - GoCAD sgrid (semi-regular)
      - UBC
      - Noddy
      - VTK rectilinear grid (semi-regular or regular)
    - Triangulations
      - GoCAD Tsurf
      - AutoCAD dxf
      - CSV with Metadata
      - VTK UnstructuredGrid file format

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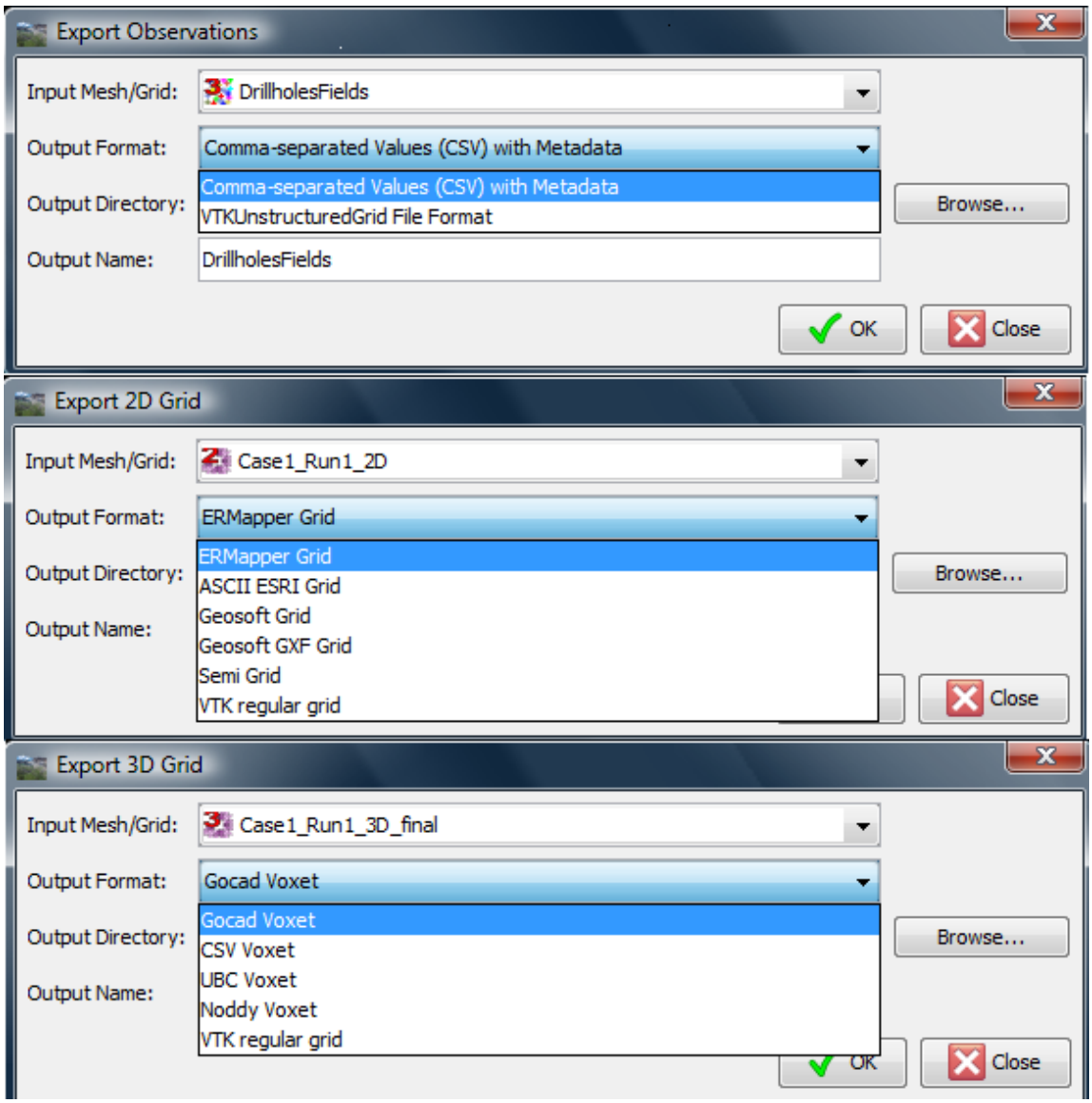

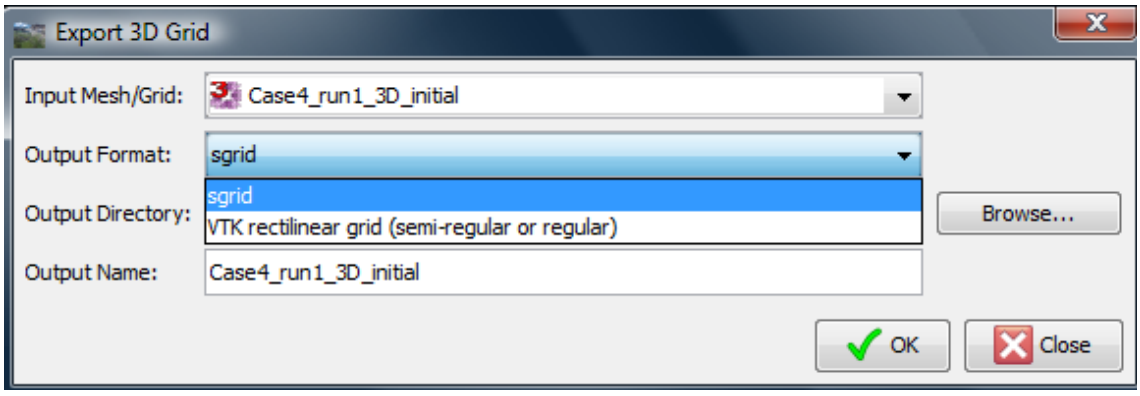

- The sgrid format is presented as the default format for Semi Regular or Irregular 3D grids whereas the Gocad Voxet format is the default format for Regular 3D grids.

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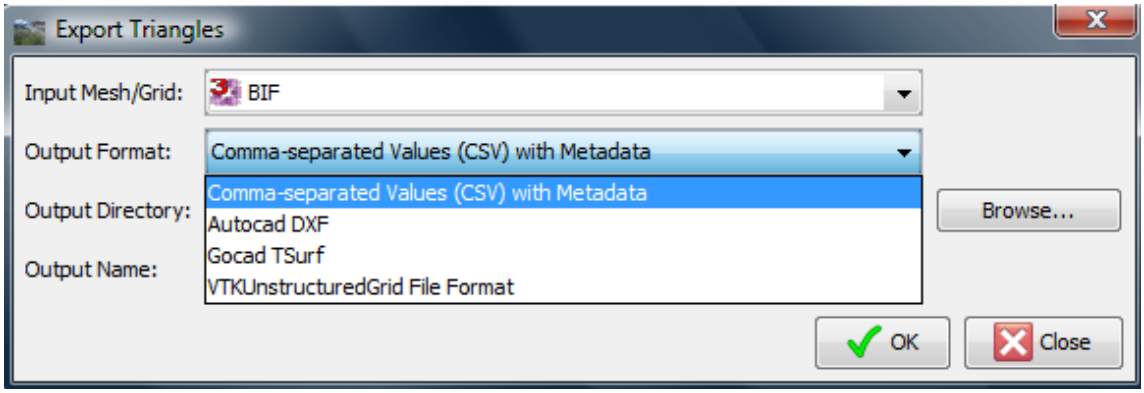
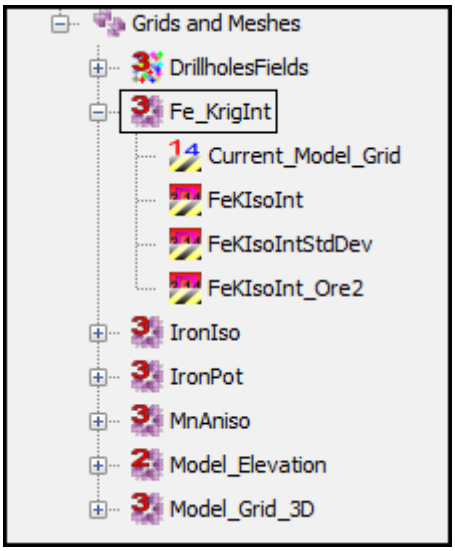


- All supported Mesh Grid export formats are fully documented in the **Export** section of the manual.

- **Compute New Field...**
  - The Mesh and Grid Calculator will compute new fields from those fields contained within the current mesh grid. This becomes more powerful once the model lithology is added ie **Add Current Model Field**
  - It has a broad suite of mathematical and logical functions to draw on as shown in the Calculator dialog below.
  - The example in the formula window shows how the kriging result FeKIsoInt can be masked to a particular formation.
  - If(Current_Model_Grid == 4; FeKIsoInt; NaN) copies the FeKIsoInt variable to a new voxet where the formation equals 4 (Ore2) and sets the other formation voxels to Null.



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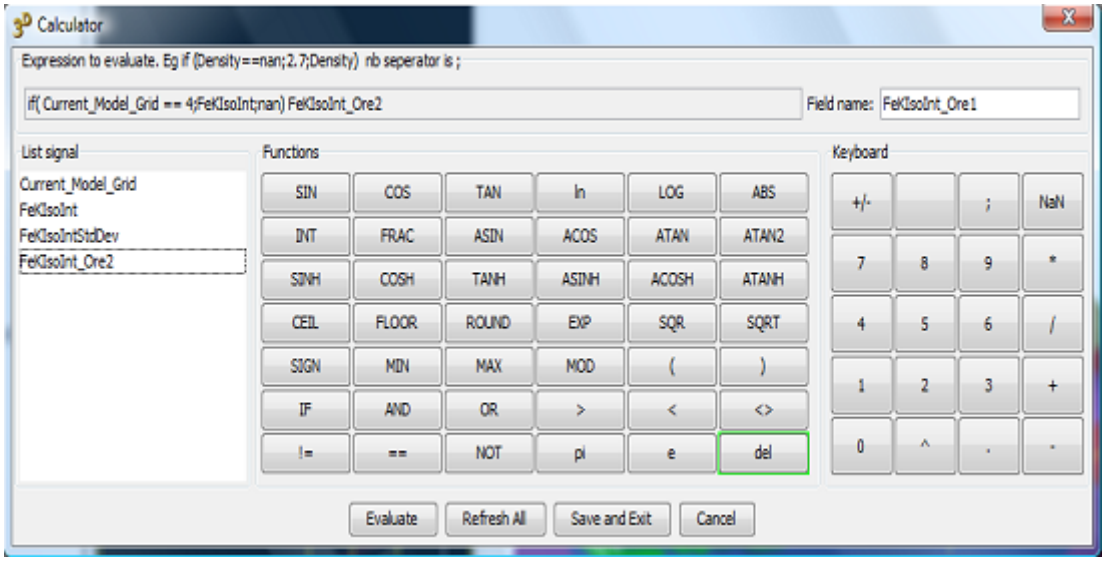

- The Calculator is also very useful when analysing stochastic inversion results. Density and susceptibility properties can be examined spatially by formation to analyse how they are migrating during the inversion process. The actual formation boundary changes can also be analysed by subtracting the Initial lithology voxet from the MostProbable or Final lithology voxets. Two examples follow (TBD).
- Mesh and Grid Calculator Syntax
  - The Calculator syntax has some similarity to that used in Excel formulae but the separator is a "**;**" not a ",".
  - The calculator's logical AND and OR syntax is not Excel like but more traditional.
  - Nested structures are possible with the use of round brackets. Entry of formulae into the Calculator is by use of the mouse only;
  - the keyboard cannot be used and pasting a formula from the clipboard is not possible.
- Mesh and Grid Calculator Syntax Examples
  - **IF**; Remove the Above_Topo voxels (0) from grid; set them to Null.
    - **IF(*Density*= =0;*nan*;*Density*)**
  - **AND**; Null the values between 2.66 and 2.68 in Fld1.
    - **IF((*Fld1*>2.66) AND (*Fld1*<2.68);*nan*;*Fld1*)**
  - **OR**; Set Lithology 3 in Fld1 to Null
    - **IF((*Fld1*= =2) OR (*Fld1*= =4);*Fld1*;*nan*)**
  - **LOG**; transform field SusceptReg5 to log10
    - **LOG(*SusceptReg5*)**
  - **EXP** and **LN**; Back transform LogSusceptReg5 from log10 space (overcomes lack of inverse LOG or Power function)
    - **EXP(*LogSusceptReg5**LN(10))**
  - Examine changes in density for Fm=2 between the inversion starting density and the inversion final density; subtracting two **IF** tests
    - **IF - IF**; **(IF(*InLith*= =2;*InDen*;nan)-IF(*FinLith*= =2;*FinDen*;*nan*))**

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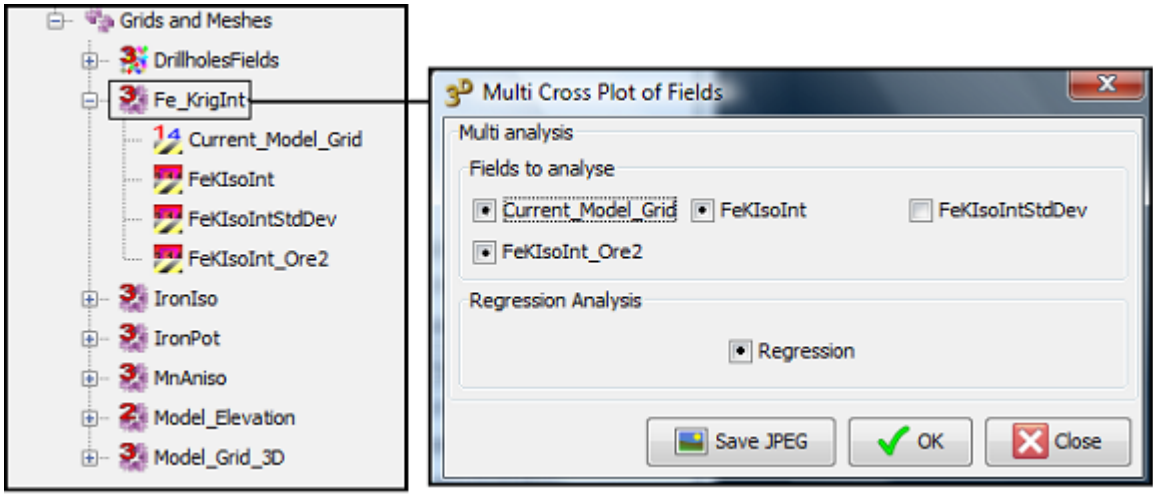
- As above but set the result to Null if the difference between the IF's is 0.
  - **IF((IF(*InLith*= =2;*InDen*;nan)-IF(*FinLith*= =2;FinDen;nan))= =0; nan; (IF(InLith= =2;InDen;nan)-IF(FinLith= =2;FinDen;nan)))**

- **Multi Crossplot with**
  - The Multi Crossplot allows the user to choose multiple fields from the current mesh grid for scatter plot and histogram analysis.
  - The Crossplot dialog is shown below
  - The user can choose to complete a linear regression as part of the multiplot analysis.



- An example multiplot analysis using the settings shown above appears on the next page as a full A4 landscape size figure.

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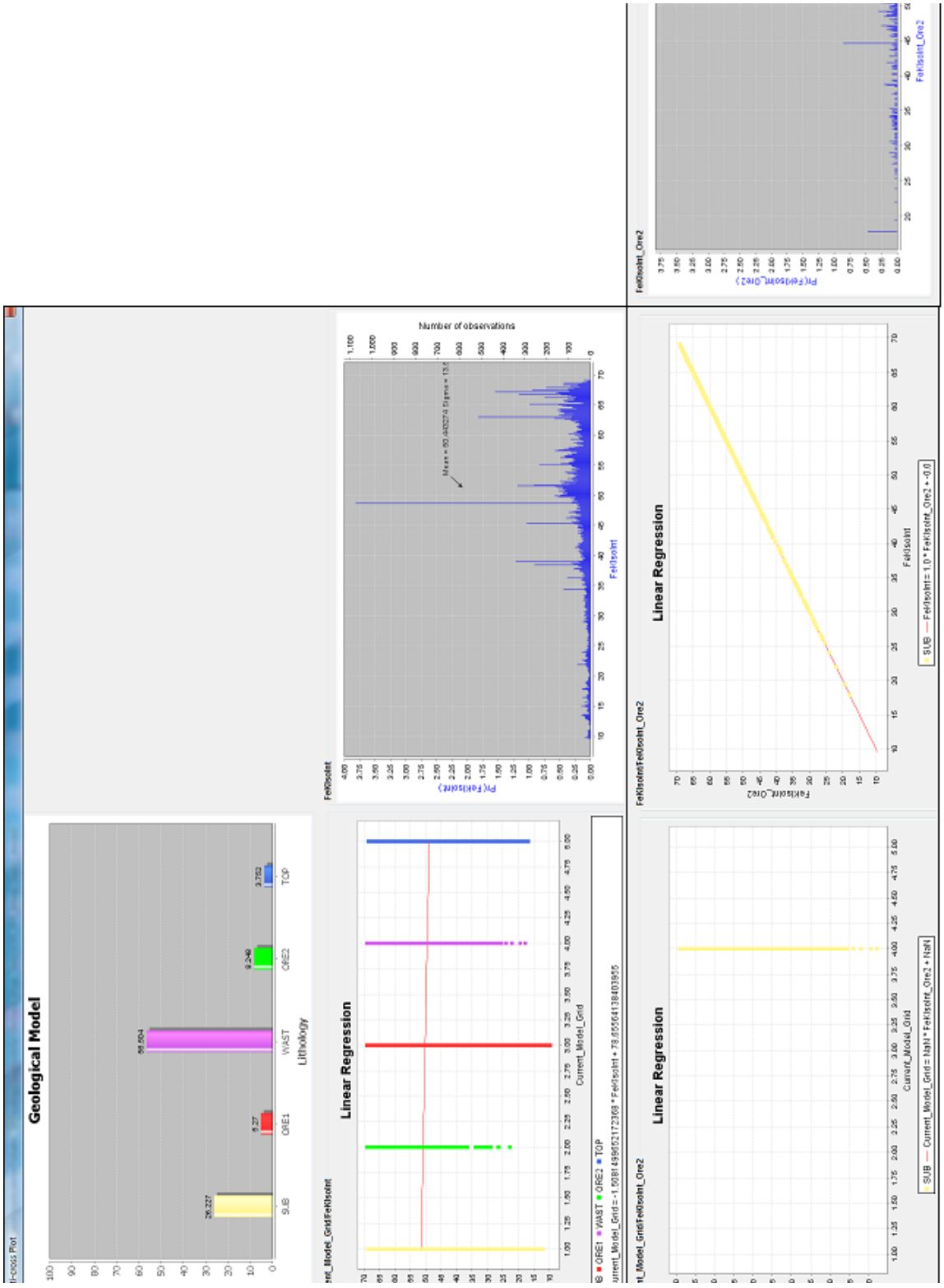

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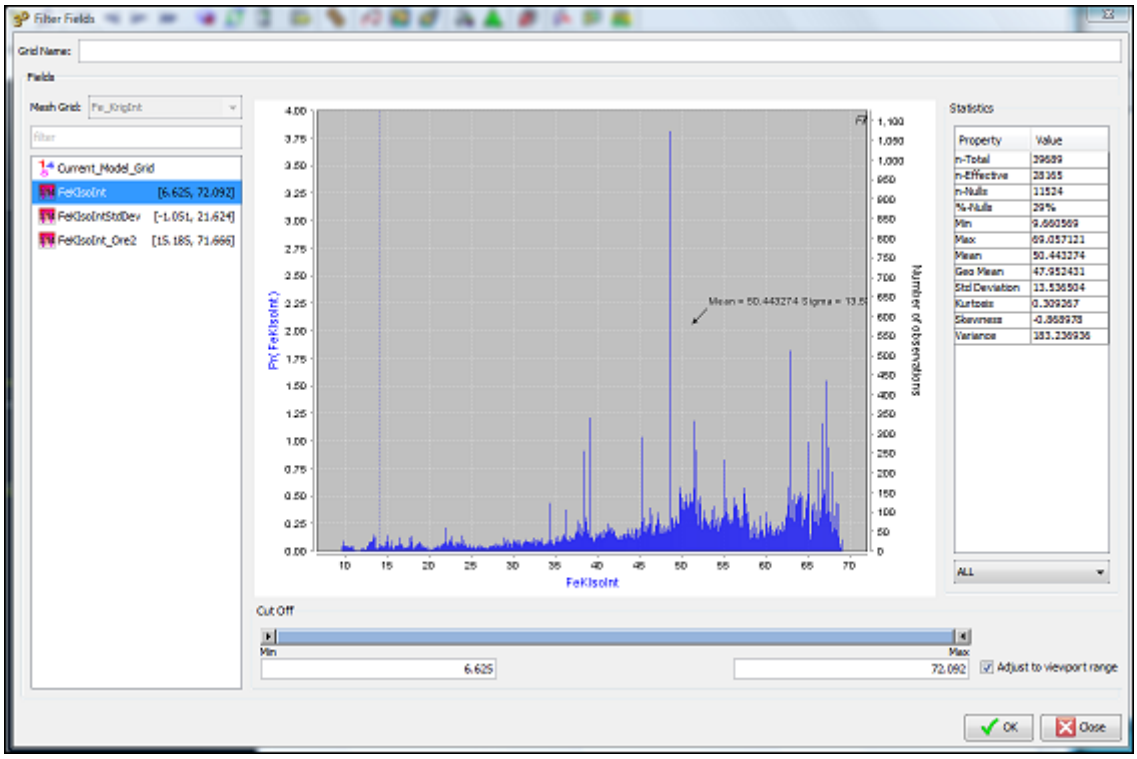
- **Group Fields**
  - Group Fields is another method for creating a new field from the existing fields of a mesh or grid by using a series of numeric field and/or date/time ranges for these fields.
  - The query takes the form of a series of logical “And”s within an enclosing “If” statement
  - The method was designed for use in microseismic analysis
  - The Group Fields dialog appears below.



- **Flow Rate Pressure Plot**
  - This a specialised plot designed for microseismic analysis

- **Delete**
  - Delete the selected mesh grid from the 3D GeoModeller project

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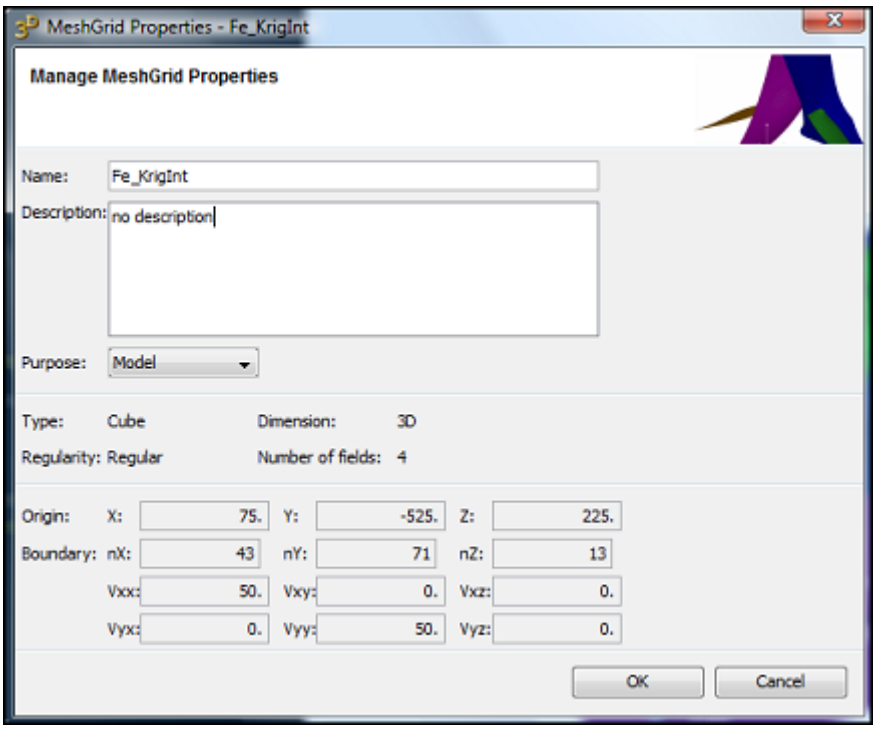
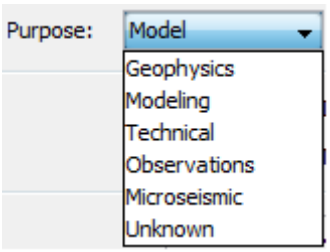
- **Properties**
  - The **Properties** dialog contains the following information
    - ***Name*** - The mesh or grid name can be edited here
    - ***Description*** - Edit or enter a description (history or source)



    - ***Purpose*** - Choose the mesh or grid purpose from the drop down list



  - The lower dialog panel summarises the mesh or grid type, regularity, number of fields, the origin and the cell/voxet dimensions where appropriate.

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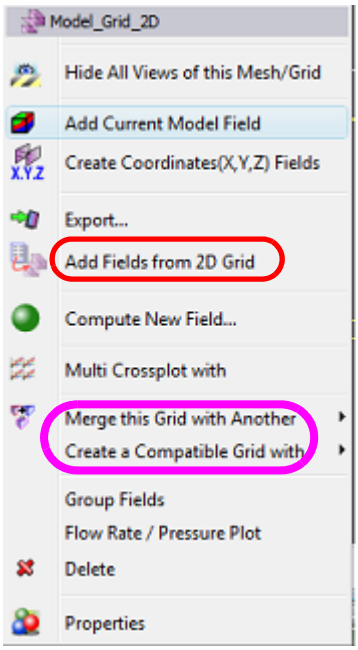
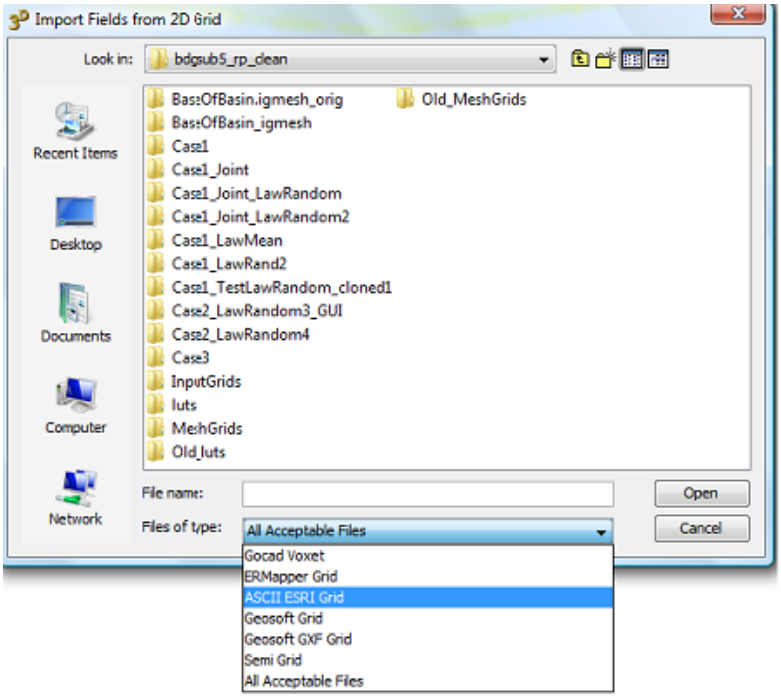
2D Grids Context Menu

- Right clicking on an individual 2D grid in the **Explore** tree produces the following dialog of choices for the Model_Grid_2D Elevation grid.
- Three extra operations are available for 2D and 3D Grid or Voxets that are not available for the Irregular Vertex Meshes discussed above. One of these is only available for 2D Grids and is highlighted in red and discussed below. The other two options highlighted in magenta are discussed under the **3D Grids Context Menu** in the next section.



- **Add Fields from 2D grid**
  - Selecting this operation produces the following dialog. 2D grid fields can be imported into an existing 2D Grid from any of the grid formats listed below.



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3D Grids or Voxets Context Menu

Right clicking on an individual 2D or 3D grid in the **Explore** tree produces the following dialog of choices for the Fe_KrigInt regular grid.

This dialog includes two extra operations for 2D and 3D Grids or Voxets that are not available for Irregular Vertex Meshes.

- **Merge this Grid with Another**
  - This operation allows two 2D or 3D grids with different geometries to be merged with one another. The user selects a grid (the Master) and selects "Merge this Grid with Another". A second grid is selected from the available list.
  - The Master will govern the merge process. The Master may be an empty grid created for the purpose of combining grids of different resolutions and/or extents
  - The fields of the second grid are sampled on to the Master.
  - Finally a new 3D grid is created with the geometry of the Master and the fields of the two grids. The fields of the two grids do not overwrite each other but retain the original gid name as a prefix to the field name. The grid Calculator can be used to merge the contents of the two fields once they are in the same grid.

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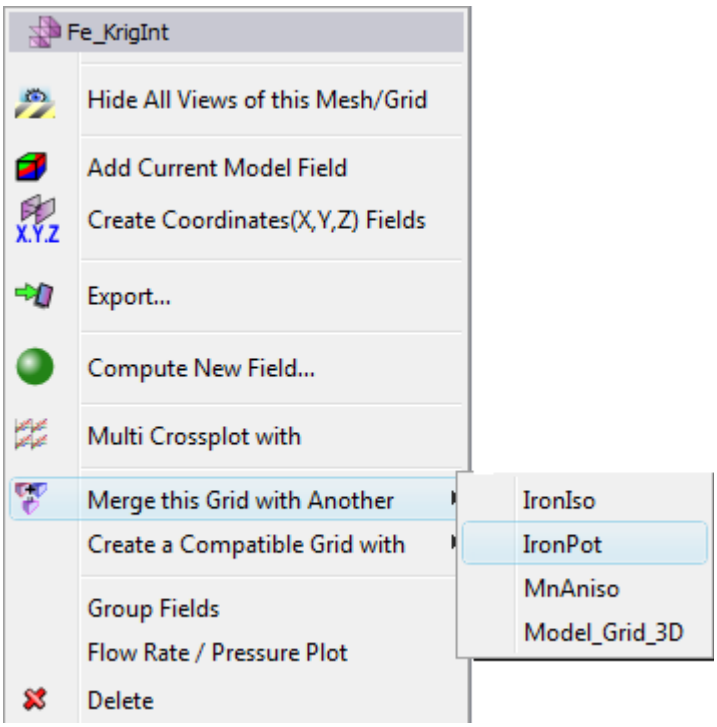
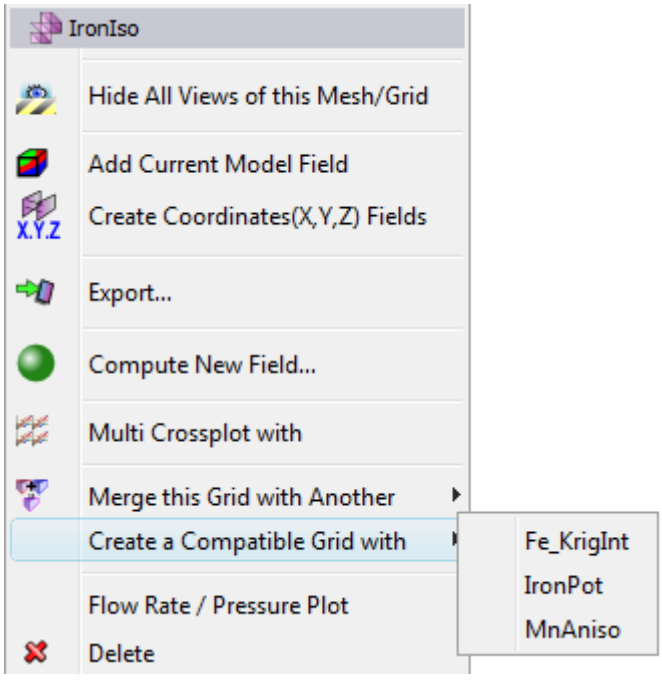


- **Create a Compatible Grid with**
  - This operation creates 2D and 3D grids compatible on x and y coordinates.
  - For example if we have a 3D grid with a given geometry we can obtain a 2D grid with the same geometry in x and y (same origin, same spacing in x and y, same number of points).
  - Alternatively if we have a 2D grid then we can build a 3D grid with a field containing the model. The geometry of the 3D grid in x and y will be the same as the 2D one, the geometry of the grid in z is defined by the user in the interface.
  - Note: This option does not appear to be working TBD!!



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From Mesh and Grid Fields Context Menu

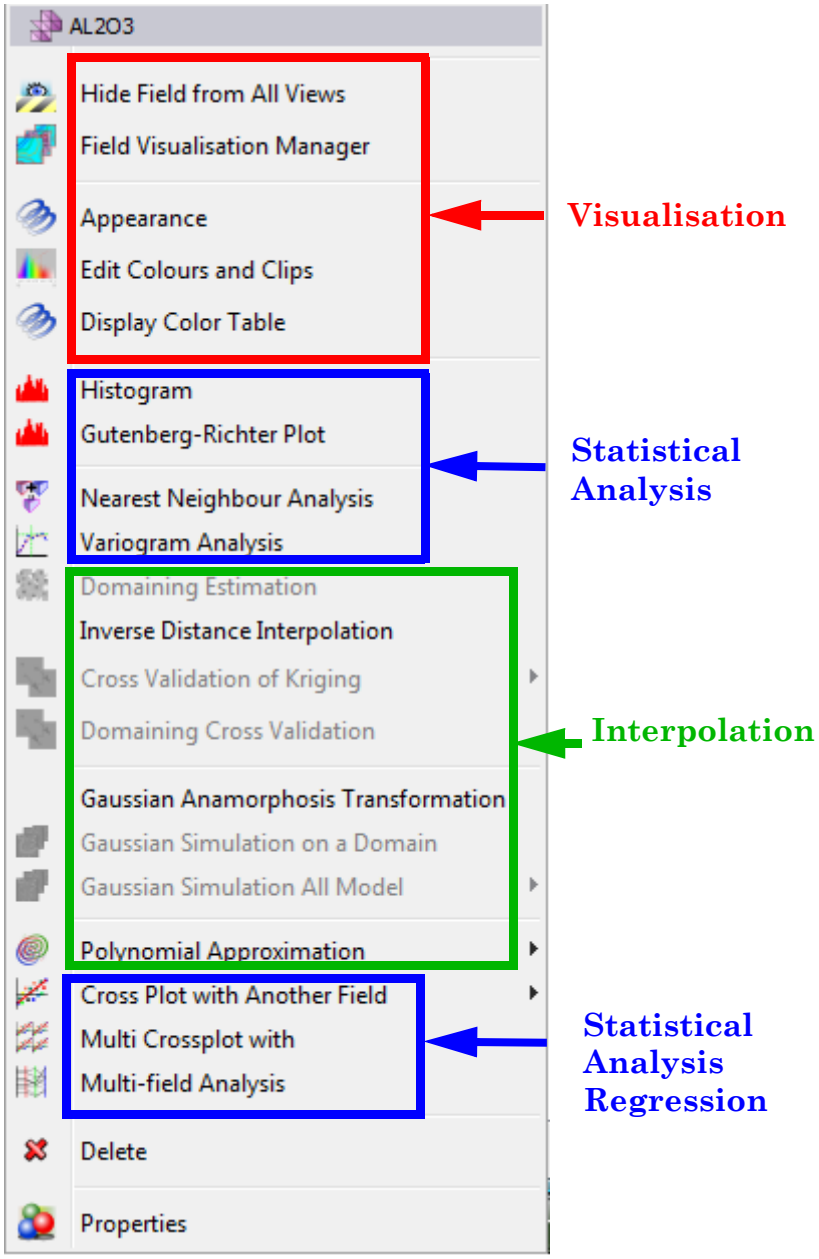
Parent topic: Mesh Grid Operations

The context menus at the Mesh and Grid "**Fields**" level (Right Click on a mesh grid Field) contain functions for interpolation, exploratory statistics and visualisation. The available options vary depending on the type of Mesh or Grid containing the field.

Options will be greyed out until the appropriate data is available to perform the required function. For instance Domaining, Kriging and Simulation require a prior variogram analysis on the selected field

The options available for all field types are described under the headings of Mesh and Grid Visualisation, Interpolation and Statistical Analysis below the individual menu summaries.

- Irregular Vertex Mesh (Point Cloud) Field context menu functions



- All available Field options can be used with Irregular Vertex Meshes (Point Clouds) with the exception of the Make Surface Shells option for 3D grids

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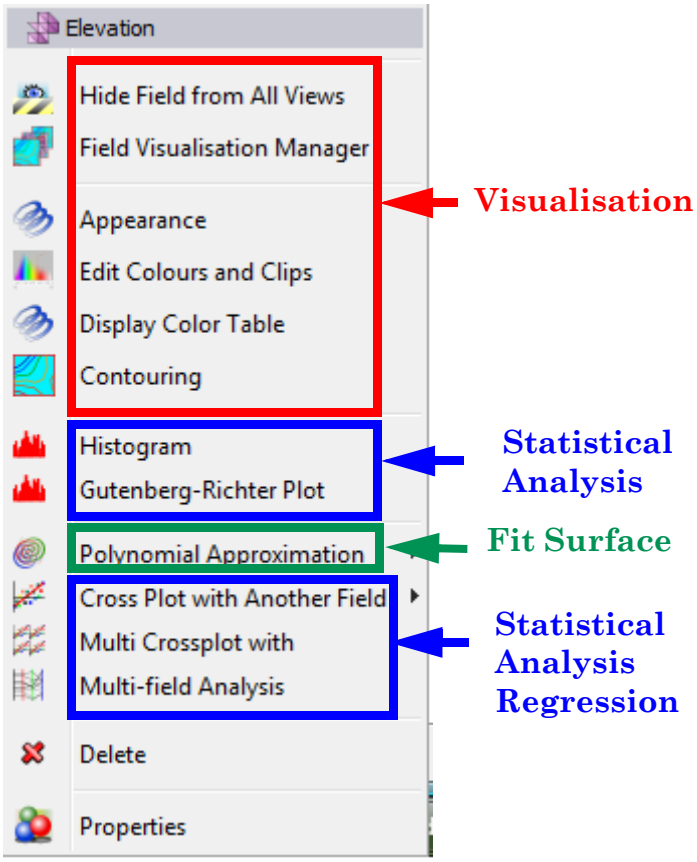
- 2D Grid Fields
  - The 2D Grid Field context menu includes all of the point cloud functions except those used in Interpolation and Nearest Neighbour Analysis



- 3D Grid Fields
  - The 3D Grid Field context menu includes all of the point cloud functions except those used in Interpolation and Nearest Neighbour Analysis. It includes one extra function which is only available for a 3D field, "**Make Surface Shells**" which extracts triangulated Shells or Surface observation points from 3D grids of formations or numeric fields. These products are useful for revising geological models following inversion.

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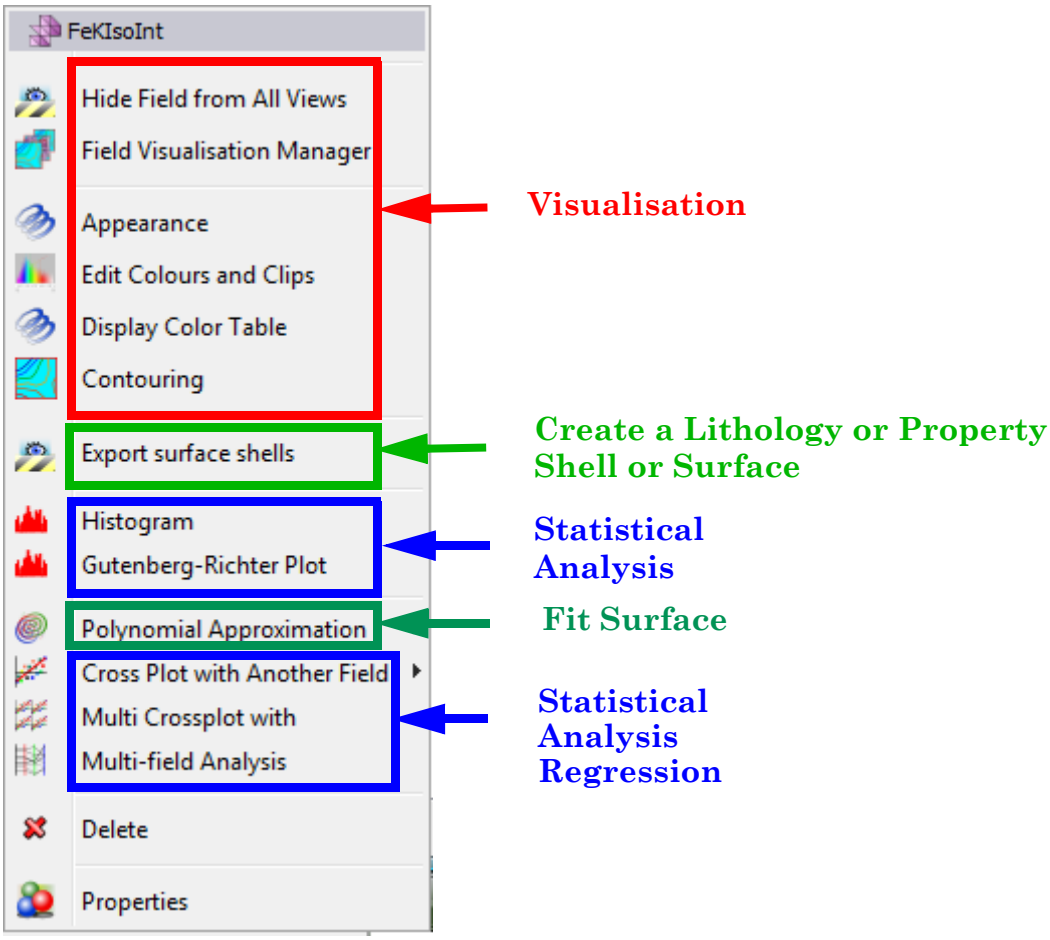
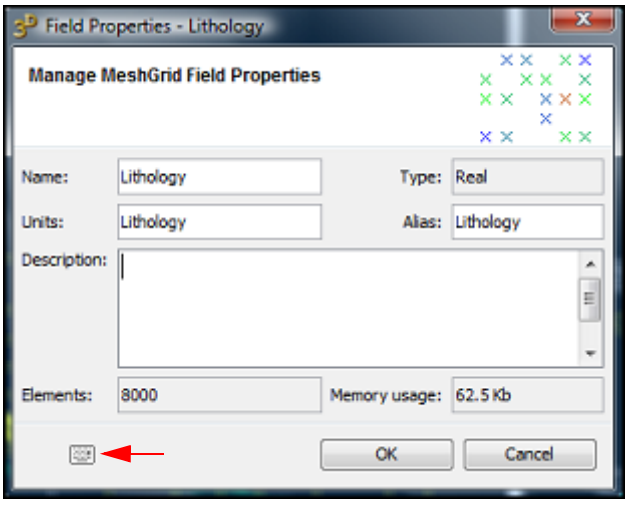


- The Field context menu management functions, **Delete** and **Properties** are common to all of the Field data types and are described here.
  - **Delete**
    - Deletes a field from any Mesh or Grid Type
  - **Properties**
    - The Field Properties dialog allows the user to carry out the following data management functions



- **Name:** Change a Field **Name**
- **Units:** Edit **Units** ie %, ppm, SI
- **Alias**: Edit the **Alias**.

If a lithology voxet is to be visualised in Pile colours and the Histogram tool is to have the ability to view statistics by Formation, then the Lithology voxet must have the alias set to Lithology

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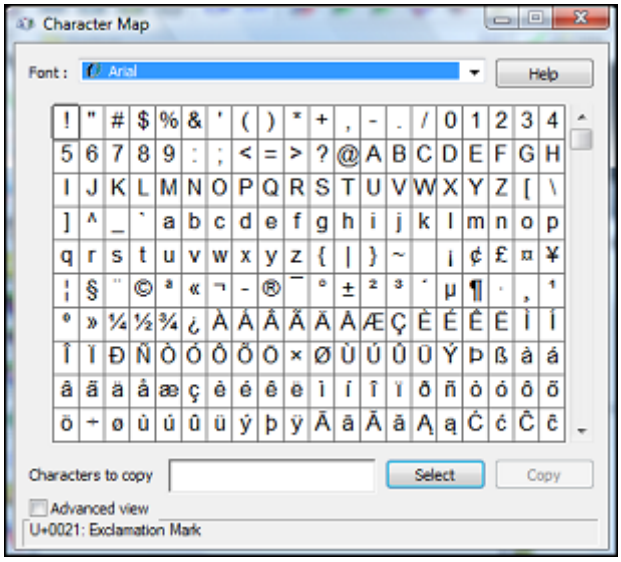
- **Field Description -** Add a description of the Field ie history.
- **Type** - Describes the Data type (not editable).
- **Elements -** The number of vertices, grid cells or voxels in mesh or grid.
- **Memory Usage** - Memory required to load
- The Character button (red arrow) in the dialog allows the user to open the Chracter Map to choose special characters when editing the Units field



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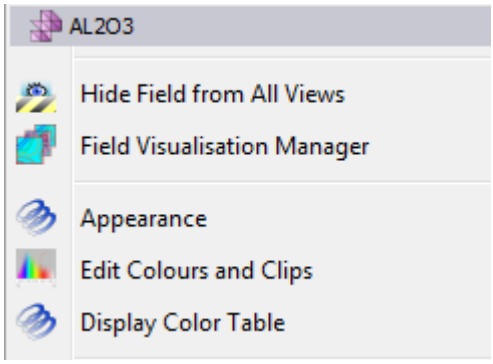
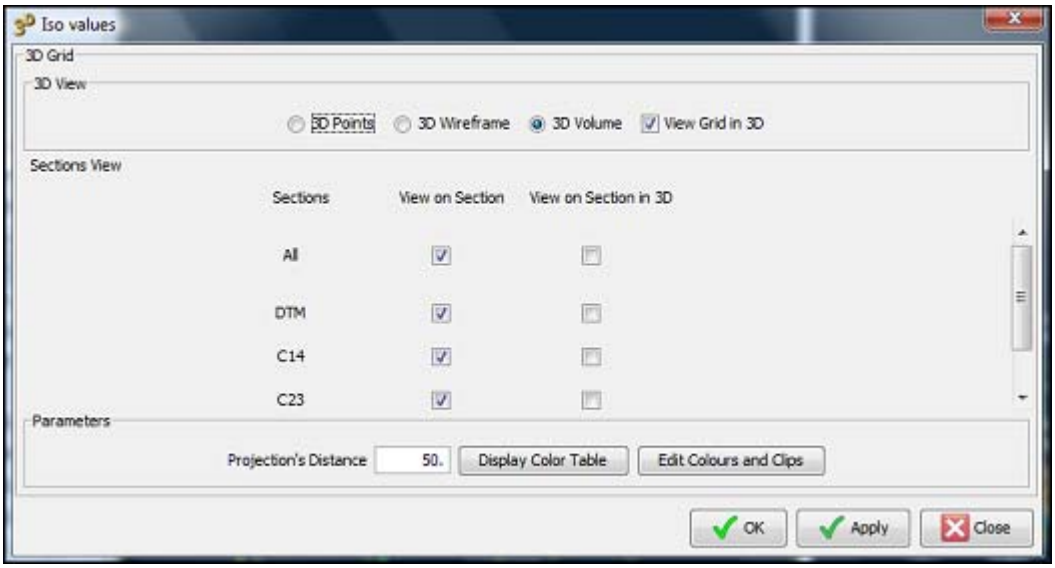
Mesh and Grid Visualisation

Parent topic: 3D GeoModeller Reference

The following functions are available in the Field context menus for visualising meshes and grids on sections in the 2D Viewer and in the 3D viewer



- **Hide Field from All Views**
  - Removes all views of the Mesh or Grid from the 2D and 3D Viewers
- **Field Visualisation Manager**
  - Manages where the Mesh or Grid is displayed and the display mode (3D point, wireframe, volume etc)
    - The Visualisation Manager is sensitive to the field type selected for display
      - 3D Points (Irregular Vertex Mesh from drillhole assays or geophysical logs).



- Example: 3D Drillhole vertex mesh (Fe %) projected onto 2D section (50m projection distance) and in the 3D viewer in 3D Volume mode.

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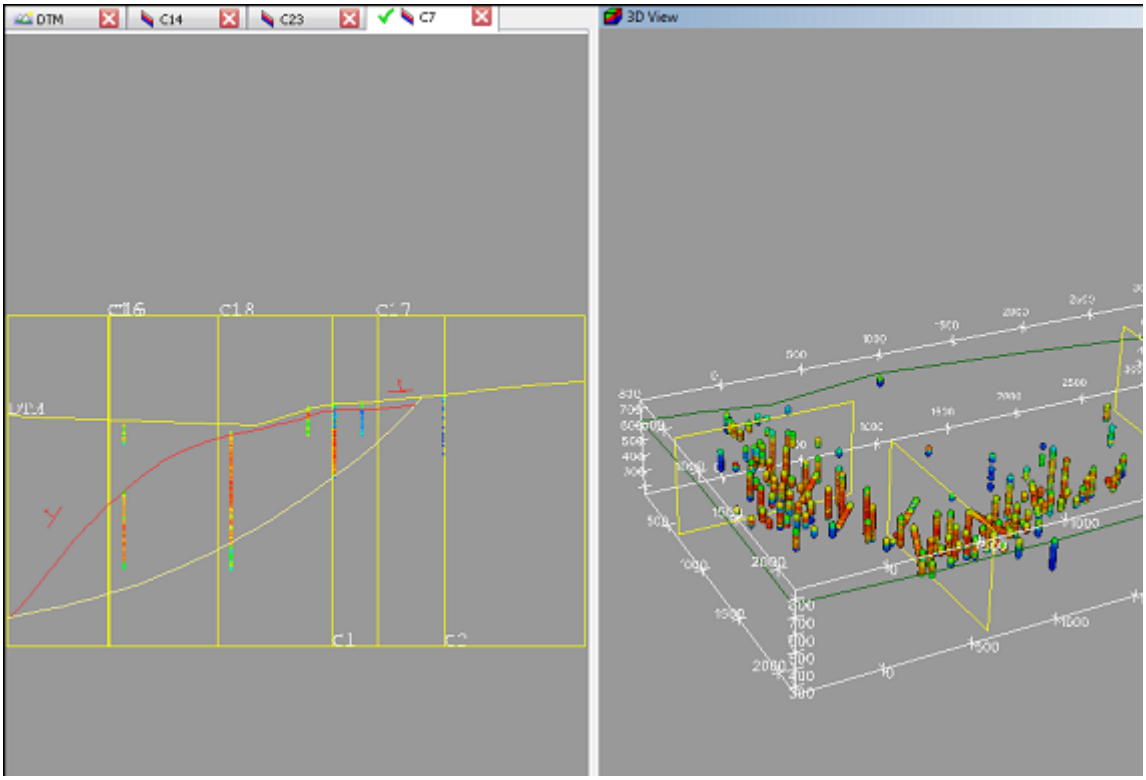
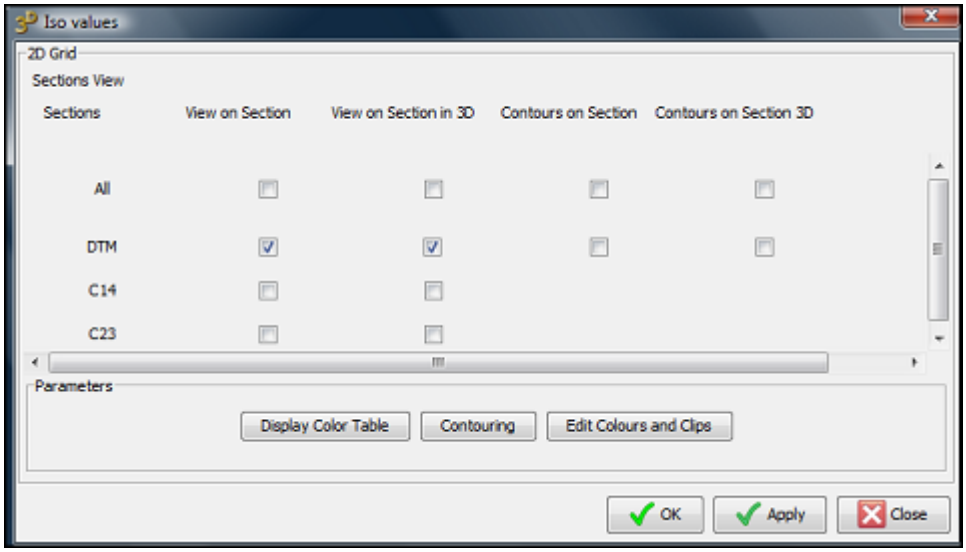


- 2D Grids (DTM, measured/observed geochemical or geophysical grids or geophysical output grids from forward modelling and inversion).
- Display options are shown in the snap below. The user can choose the Display Colour Table, Edit Colours and Clips or display Contours.



- Example: 2D DTM on Surface Topo section and draped on the topography in the 3D viewer

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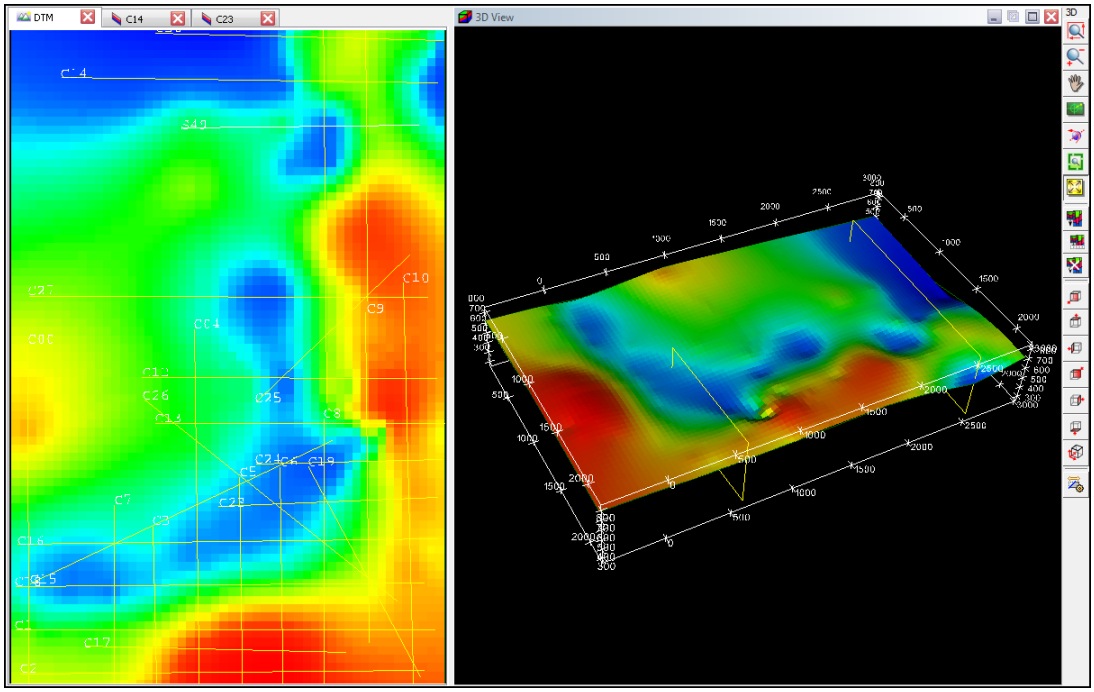
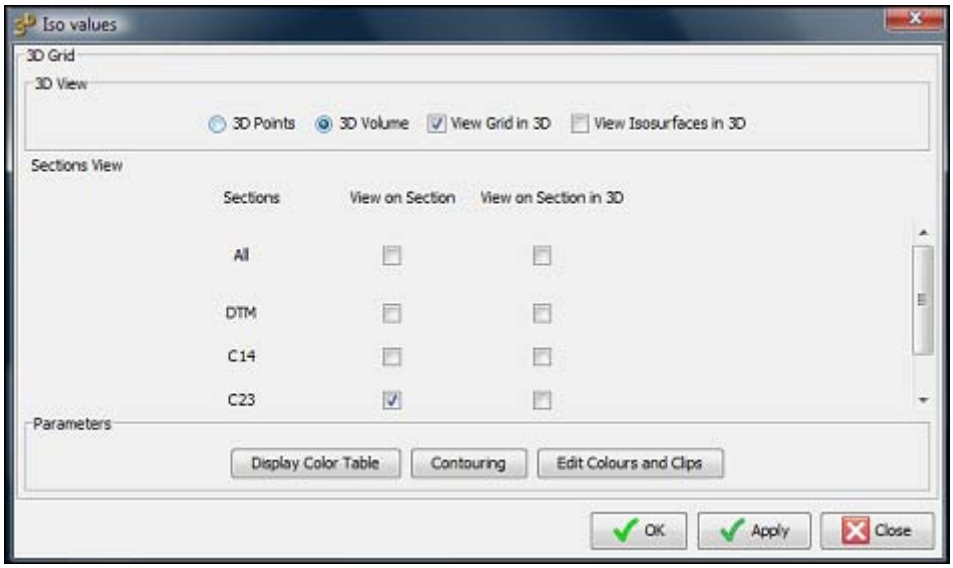


- 3D Grids (Geological model, Kriged resource, inversion geology or rock properties).



- Example1: 3D Domain kriging (pot) of Fe on vertex mesh example drill holes above. The Kriging domain was confined to the Ore2 formation.

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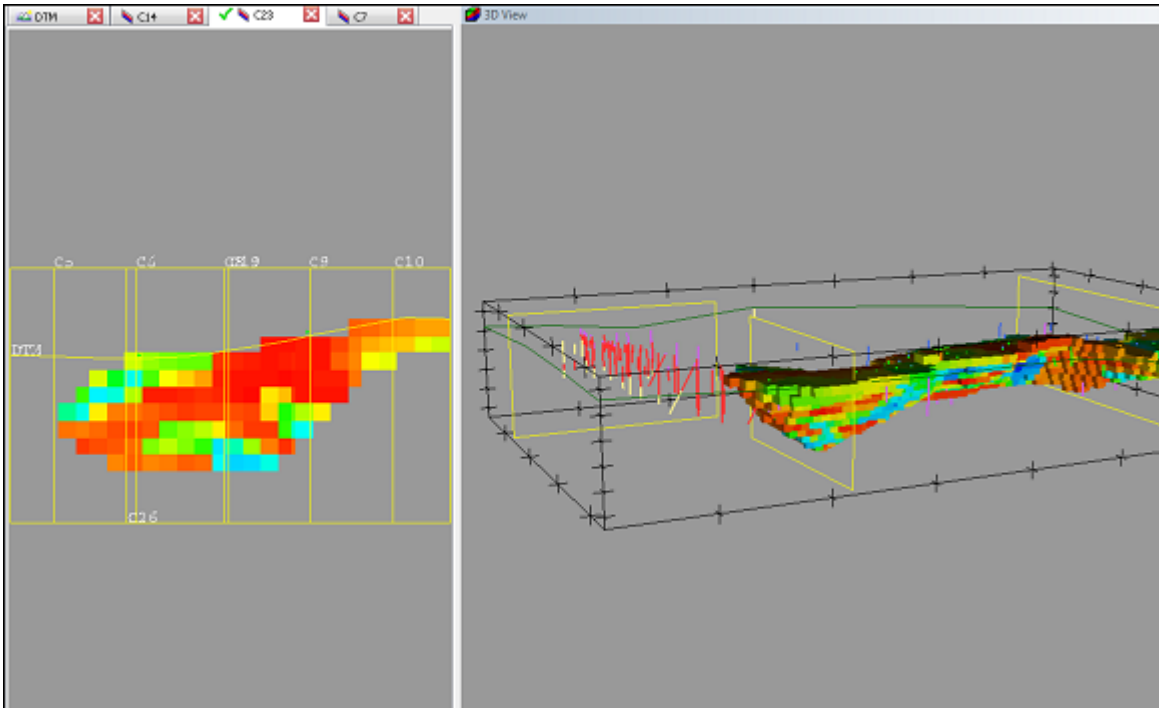
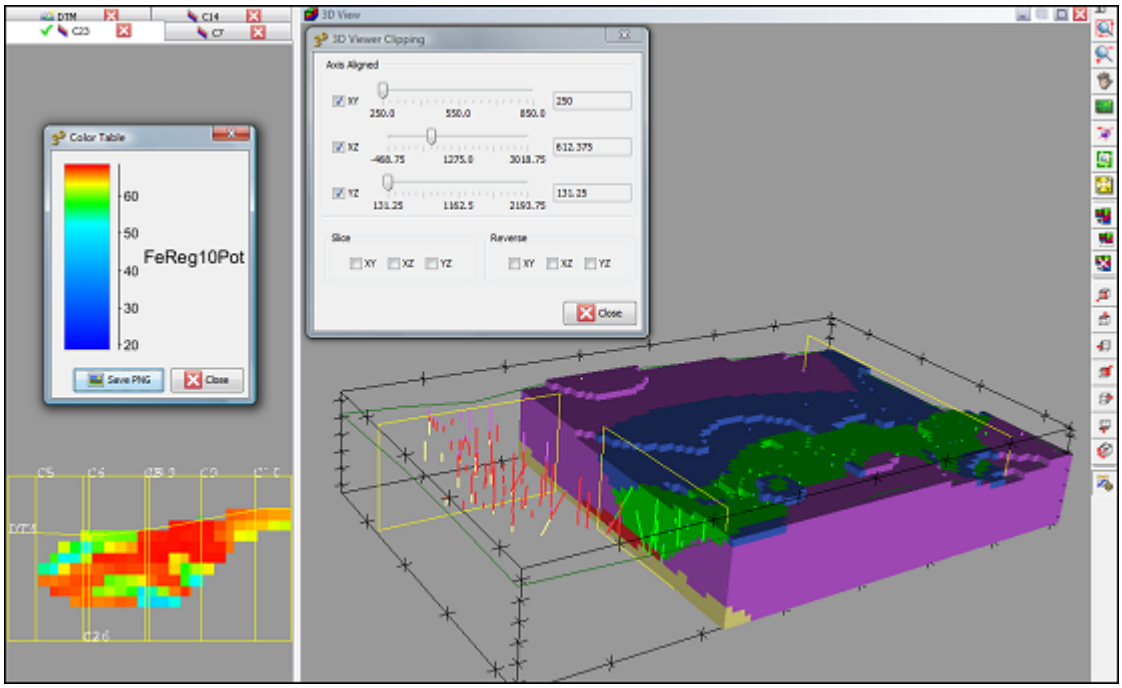


- Example2: 3D Geology grid of the model pile user the 3D viewer clipping to show section C23; Domain pot interpolated Fe grades (regularised to 10m) are shown in section C23 on left. Colour table of the Fe% grades is above 2D section display on left.



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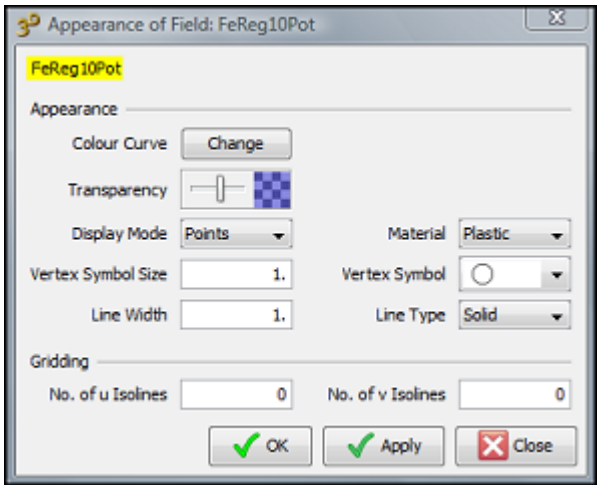
- **Appearance**
  - The Appearance Menu dialog provides the following Mesh and Grid functions



    - **Colour Curve** opens the Colour lookup table tool (**Adjust Color Curve**) dialog which is normally accessed from the **Field** context menu or from the **Field Visualisation Manager**
    - **Transparency** controls the transparency of a mesh in the 3D viewer or a grid projected to section and displayed in the 3D viewer. It does not function in the 2D Viewer
    - **Display Mode** changes the display of a triangular mesh from points (nodes) to a wireframe. It has no effect on the display of a vertex mesh which is currently fixed to the shading mode.
    - **Vertex Symbol Size** Changes the point size of a triangular mesh when it is in the *Points* **Display Mode**
    - **Vertex Symbol** sets the vertex symbol used to display points
    - The **Line** options and the **Gridding isolines** do not work in the Mesh and Grid context.
- **Edit Colour and Clips**
  - Opens the Colour lookup table tool (**Adjust Color Curve**) dialog. The main functions of this tool are:
    - **Colour**: Choose a colour lookup table from the drop down list.
    - **Data Clip:** Manually adjust the data range for the colour mapping using the numeric **Data Clip** boxes
    - **Data Clip:** Auto adjust the data range using a % population clip from drop down list.
    - Graphics window: Manually adjust the colour mapping by dragging points on the transform line until the required colour distribution is reached
    - **Transformation:** Use an automatic colour stretch such as Linear, Histogram Equalisation, Step (user sets number of steps) and LogNormal
    - **Visibility Clip:** Set the visible data limits of the display by choosing a % population clip from the drop down list or by typing the min/max values in the numeric data boxes; this is useful for looking at data with upper and/or lower cutoffs applied. Data outside the chosen clip range is removed from the display.

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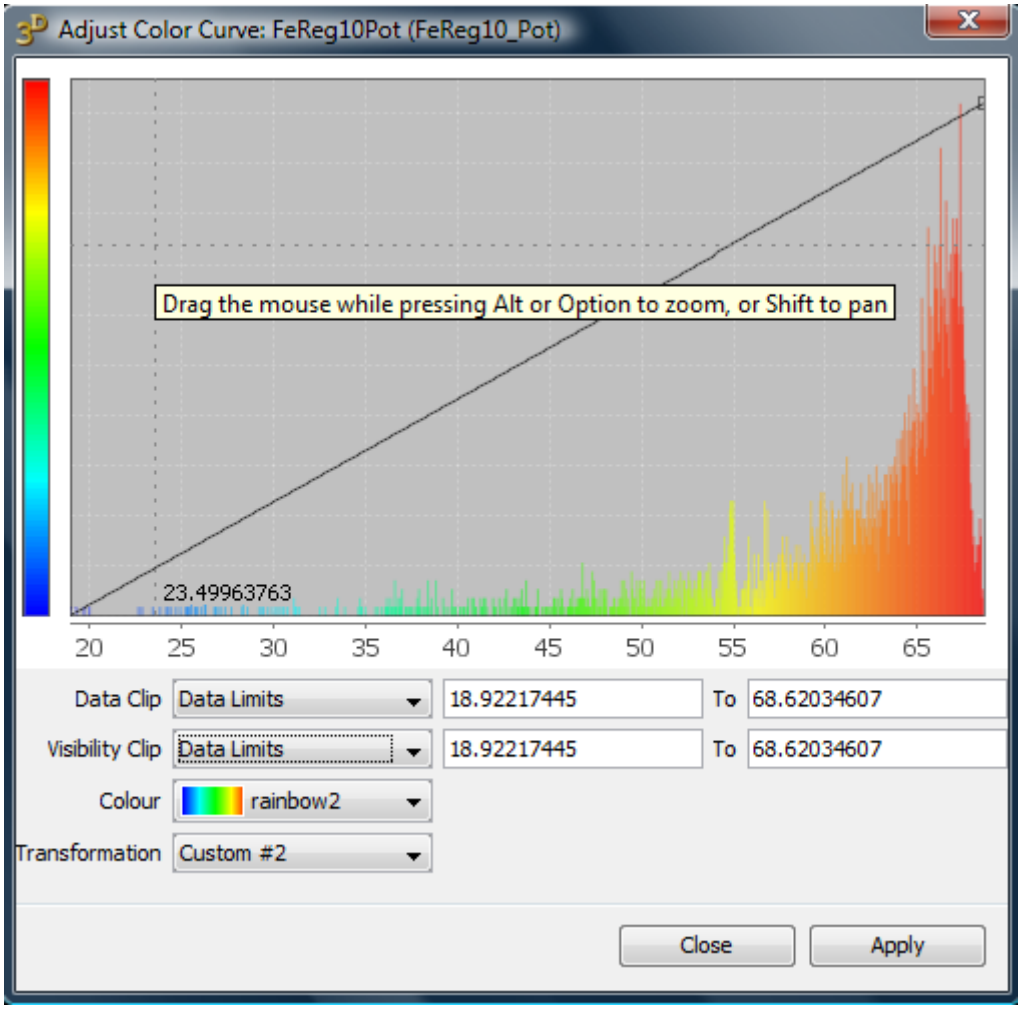
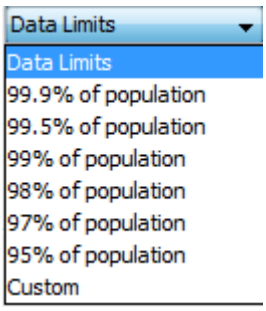
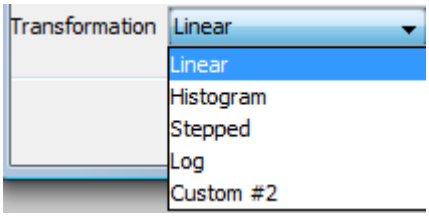


- **Data Limits** and **Visibility Clip** Drop Down list



- **Transformation** Drop Down list



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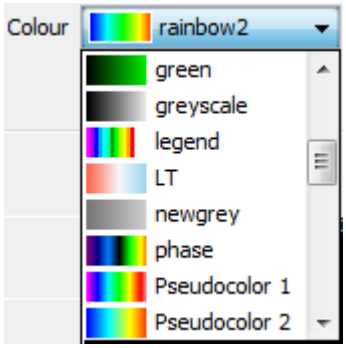
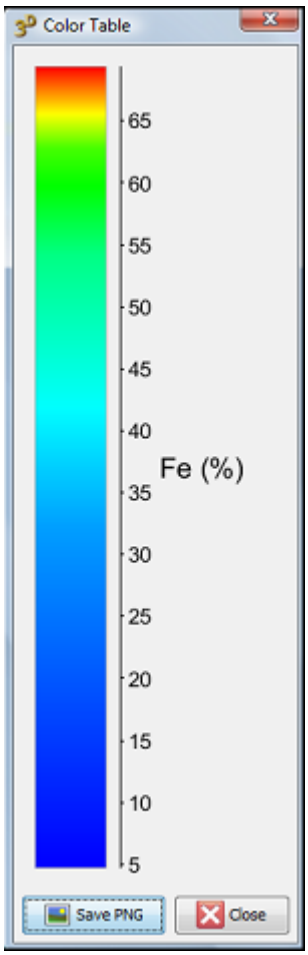
- **Colour** Lookup table Drop Down List
  - Note: User can copy any ERMapper format LUT file into the 3D GeoModeller "**lut**" directory; it will automatically be added to the Colour dropdown list on a restart.



- **Display Colour Table**
  - Displays the colour table used to visualise the current mesh or grid as a bar scale with the colour axis labelled in mesh or grid data values. The Colour bar can be saved as a png image for inclusion in presentations, maps or reports.



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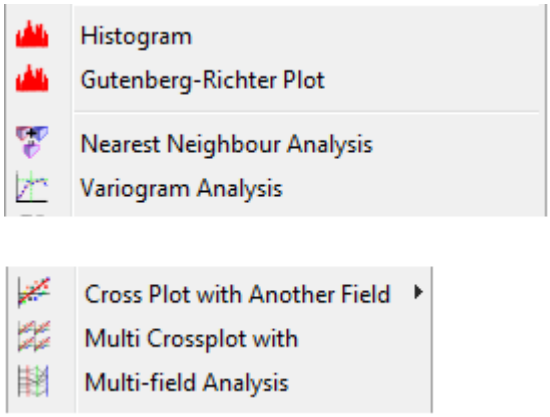
Mesh and Grid Field Statistical Analysis

Parent topic: 3D GeoModeller Reference

The Mesh and Grid Field context menu functions are:



- **Histogram**
  - The histogram function displays a standard histogram of the mesh or grid field values with an automatically generated bin spacing based on the data range
  - The dialog also displays the mesh or grid field summary statistics.
  - If the mesh or grid contains a model lithology field in numeric form (Integer index) and the field Property Alias is set to "Lithology" then the histogram dialog has a drop down lithology list which allows the user to select and generate the histogram and summary statistics for each lithology. If a Lithology field is not present the user can use the **Add Current Model field** from the Mesh Grid context menu to add the 3D GeoModeller model (Formation/Lithology) to the mesh or grid.

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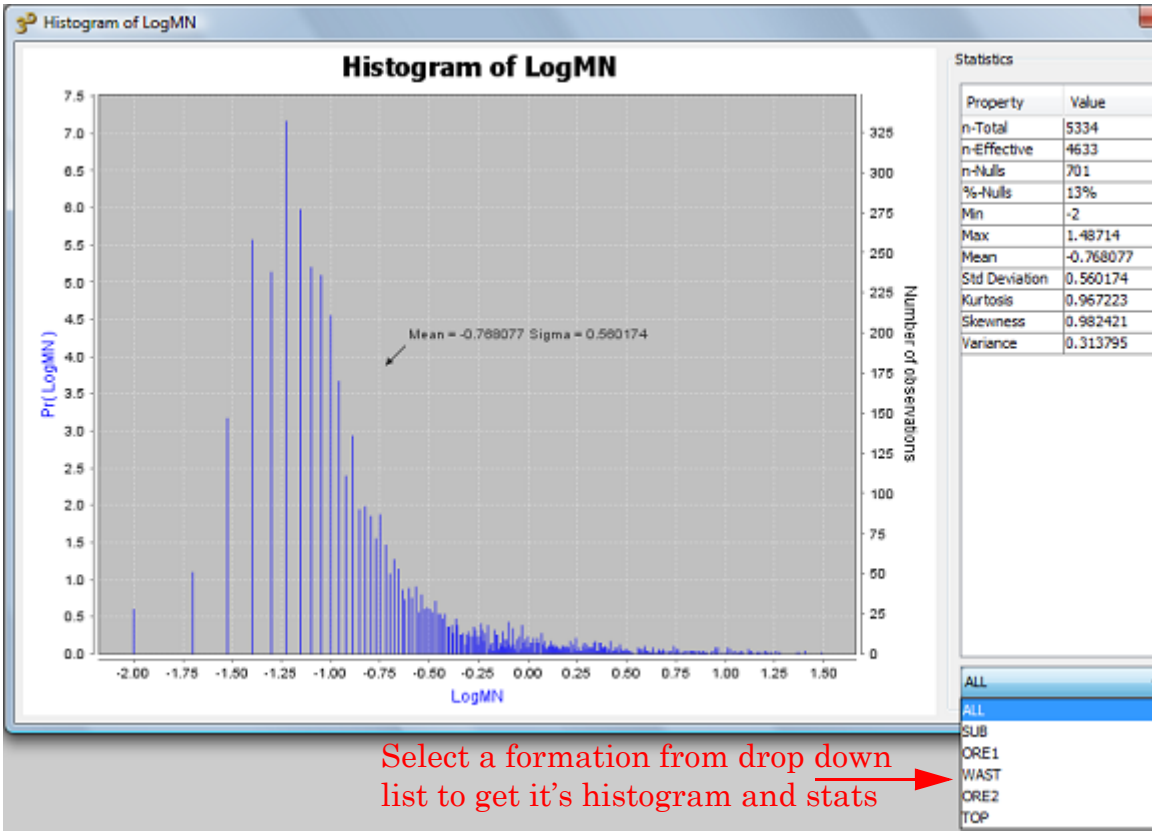
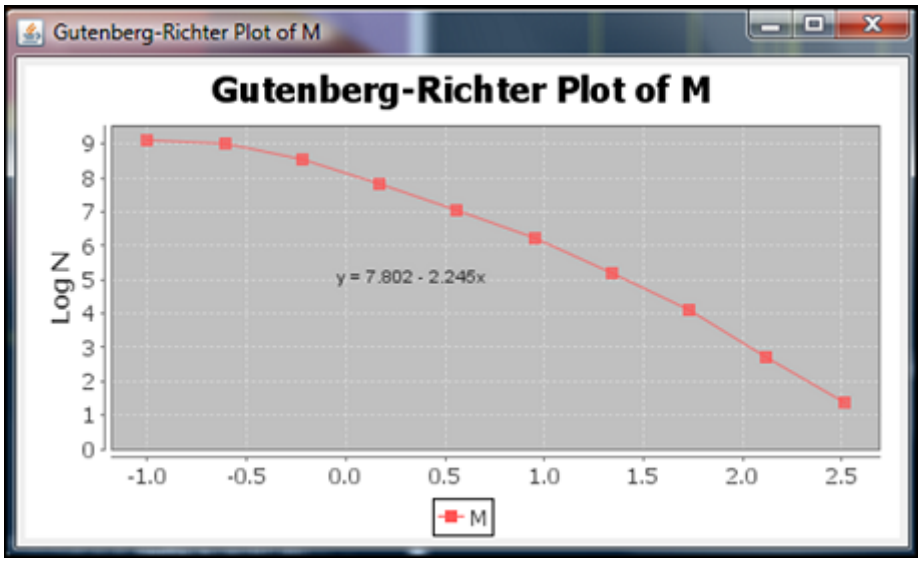


- **Gutenberg-Richter Plot**
  - This graph is used in Micro-Seismic analysis and plots seismic event frequency against magnitude.
  - In seismology, the Gutenberg–Richter law[1] (GR law) expresses the relationship between the magnitude and total number of earthquakes in any given region and time period of at least that magnitude.



  - A good reference for microseismic analysis is Tutorial J distributed with the 3D GeoModeller software.

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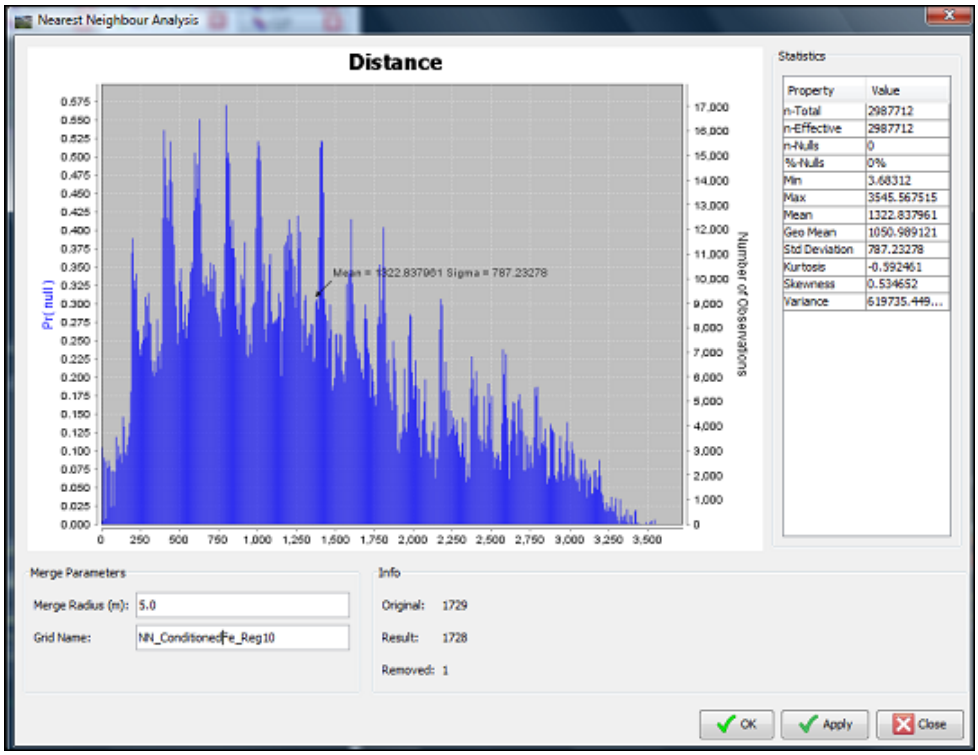
- **Nearest Neighbour Analysis**
  - This tool has two purposes
    - analyse the spatial distribution of samples by examining the distances of each sample from all the others to obtain an average sample separation; and view the binned separation distance distribution in a histogram plot
    - remove or average samples within a user chosen distance from each other;
  - Discussion
    - When analysing spatial data, one of the most important types of information required is the spacing between samples. This helps the user to choose search radii in interpolation routines so as to balance density of sampling against computation time. A large search radius will ensure the inclusion of large numbers of samples. However, if too large a radius is selected, the software will spend more time in eliminating the excess samples than in finding the relevant ones.
    - The inter-sample distance is also useful in determining the grouping intervals (lags) for variogram calculation. If the sampling is extremely irregular, it may be difficult to establish an optimum distance interval empirically.
    - Another use of "nearest neighbour" analysis is the identification of duplicate or very closely spaced sampling before kriging. Kriging routines assume that you want the estimation to "honour" the sample data. This is difficult to do if you have two samples at the same location! Also samples too closely spaced for the chosen kriging analysis can cause instability during interpolation.
    - This type of calculation takes exactly twice the time of a corresponding variogram analysis, since it must pair every sample up with every other sample --- both ways.



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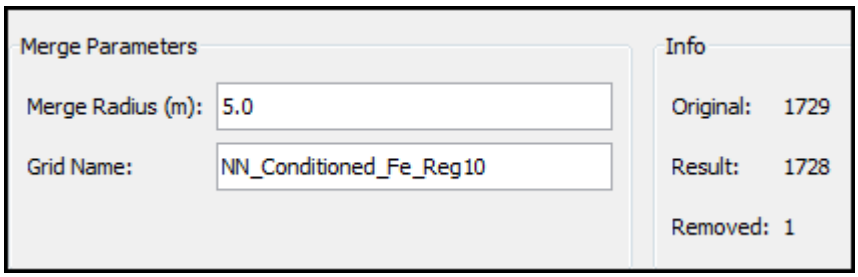
- The Nearest Neighbour Merge parameters panel is shown below :
  - Merge Radius (The Info panel auto-updates as the Merge Radius is changed)
  - Samples within the merge radius are combined using an inverse distance weighting procedure
  - The user chooses the name of the new Conditioned field



- The Statistics panel summarises the sample separation distance statistics.

Statistics

Property	Value
n-Total	2987712
n-Effective	2987712
n-Nulls	0
%-Nulls	0%
Min	3.68312
Max	3545.567515
Mean	1322.837961
Geo Mean	1050.989121
Std Deviation	787.23278
Kurtosis	-0.592461
Skewness	0.534652
Variance	619735.449...

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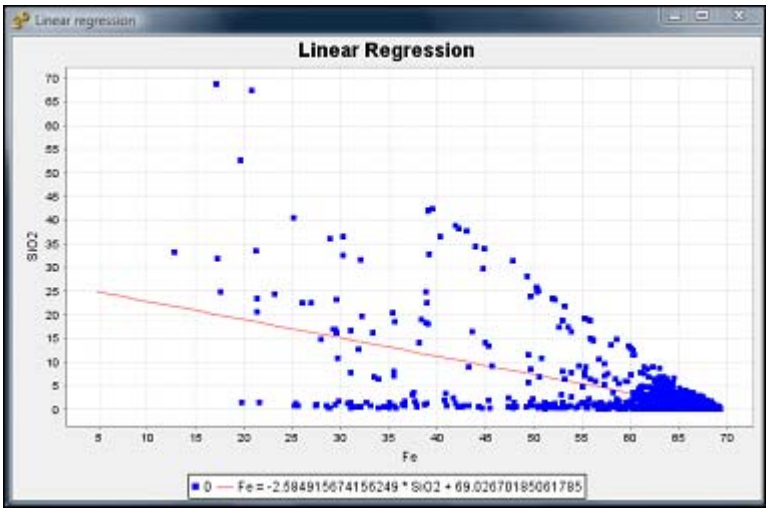
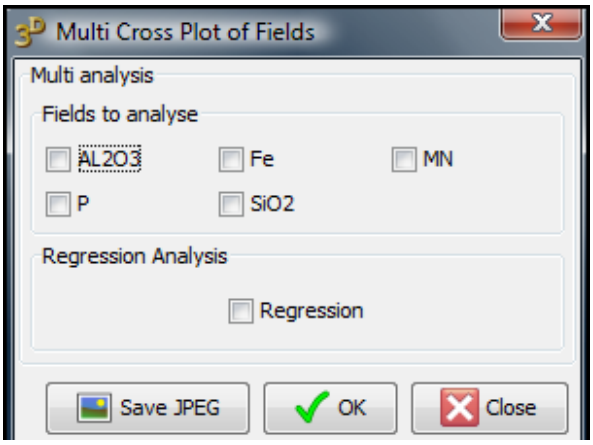
- **Cross Plot (Scatter Plot) with another or multiple fields**
  - Options are:
    - **Cross Plot with another Field;** includes a linear regression line.



    - **Multi Crossplot with**; Choice of this option pops a Field chooser and a regression option



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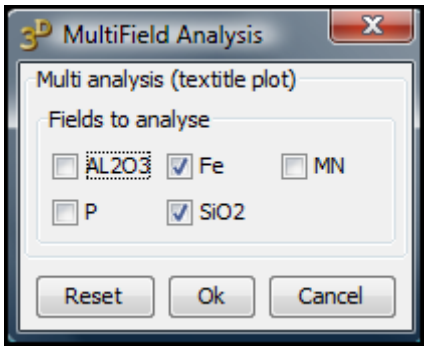
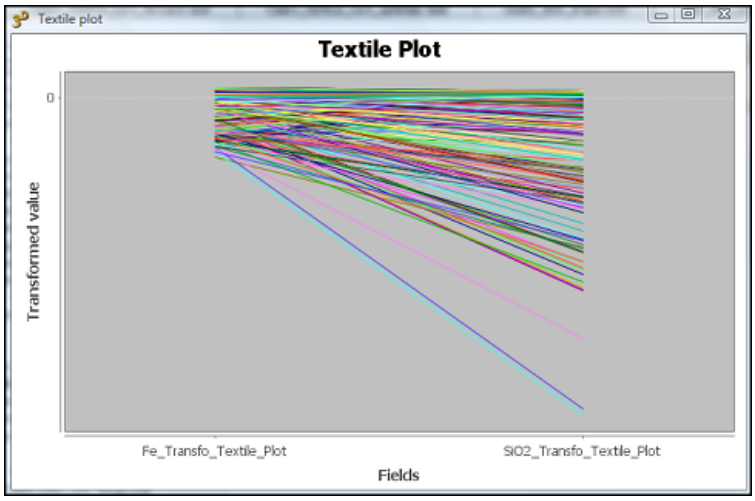
- **Multifield Analysis**
  - Multifield analysis pops a Field chooser and then produces a textile plot of the chosen Fields ie Fe and SiO2 below.



  - The textile plot is a parallel coordinate plot in which the ordering, locations and scales of the axes are simultaneously chosen so that the connecting lines, each of which represents a case, are aligned as horizontally as possible. Plots of this type can accommodate numerical data as well as ordered or unordered categorical data, or a mixture of these different data types. Knots and parallel wefts are features of the textile plot which greatly aid the interpretation of the data.



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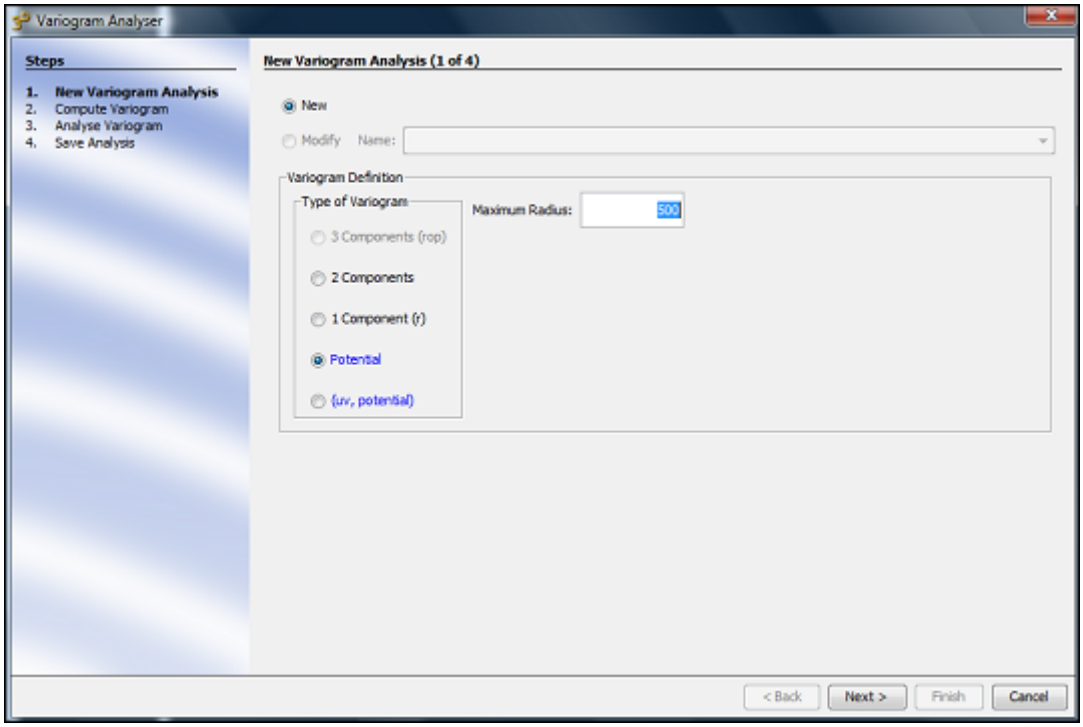
- **Variogram Analysis**
  - Selecting variogram analysis opens a wizard which takes the user through the steps required to produce a sensible variogram model prior to running the kriging interpolators. The Step1 dialog ishown below.
  - The wizard contains four steps:
    - Selection of the variogram analysis type. The user can modify an existing analysis or create a new one. The analysis could be saved as an attribute of a field of a mesh of vertices. An the same time we can define, the maximum radius to compute the pairs building the variogram and in which coordinate space the variogram will be computed.
      - In 2D we can work in (x,y) or in r (sqrt(x^2 + y^2)).
      - In 3D we can work in (x,y); in this case we don't take into account the z coordinate) or
      - In r (sqrt(x^2 + y^2 + z^2)) - For the moment the (x,y,z) analysis user interface is not implemented and is turned off or
      - using the space coordinate of a potential, or
      - using the space coordinate of the potential plus curvilinear distance along the potential. .
    - Computation of the variogram
    - Analysis (Fitting of the variogram model)
    - Saving the analysis
  - These steps are discussed fully in the Interpolation section following Surface Analysis



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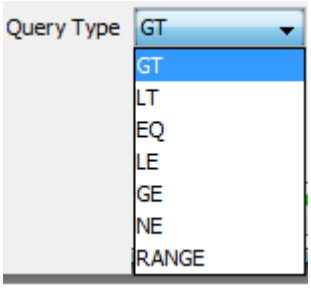
Mesh and Grid Field Surface Analysis

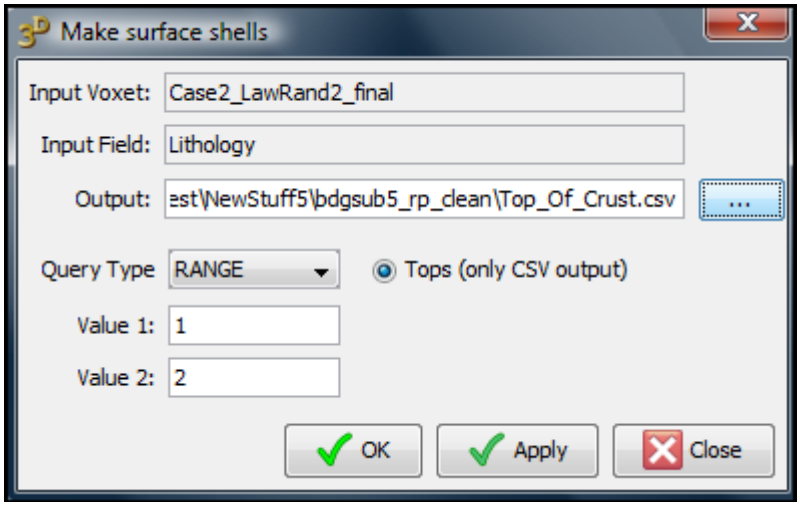
Parent topic: 3D GeoModeller Reference

- **Polynomial approximation**
  - Computes a new field from the original one, by selecting and fitting a polynomial surface of order 1 to 5 of the coordinate (here 3D coordinates x, y, z) that minimises the distance to the true value. The new field created is added to the grid, the name of the field is automatically generated.

- **Make Surface Shells**
  - Extracts triangulated Shells or Surface observation points from 3D grids of formations or numeric fields. These products are useful for revising geological models following inversion.
  - The user can select from the following Query Types to control the extracted Shell or Surface. Selecting Range allows the user to enter 2 inclusive Values



  - The Shells are saved as VTK .**vtp** poly files and the Surfaces (Tops) are saved as (x, y, z) observation points in **.csv** format
  - The Shells are auto loaded into Meshes and Grids in the Explore tree on completion.
  - The Surface observation points are imported as 3D points to the relevant formation where they can be visualised as normal and used to control the update to the formation boundary
  - Selecting Make Surface Shells opens the following dialog. This is an example of the use of the RANGE Query Type and the selection of Tops



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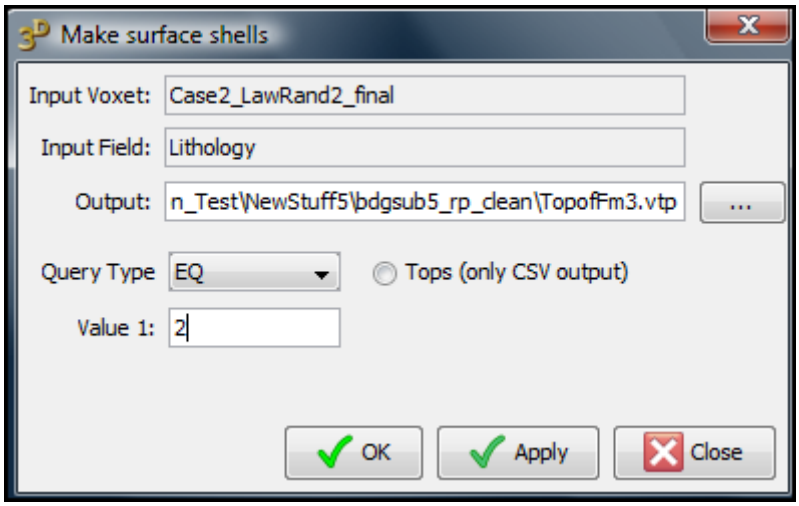
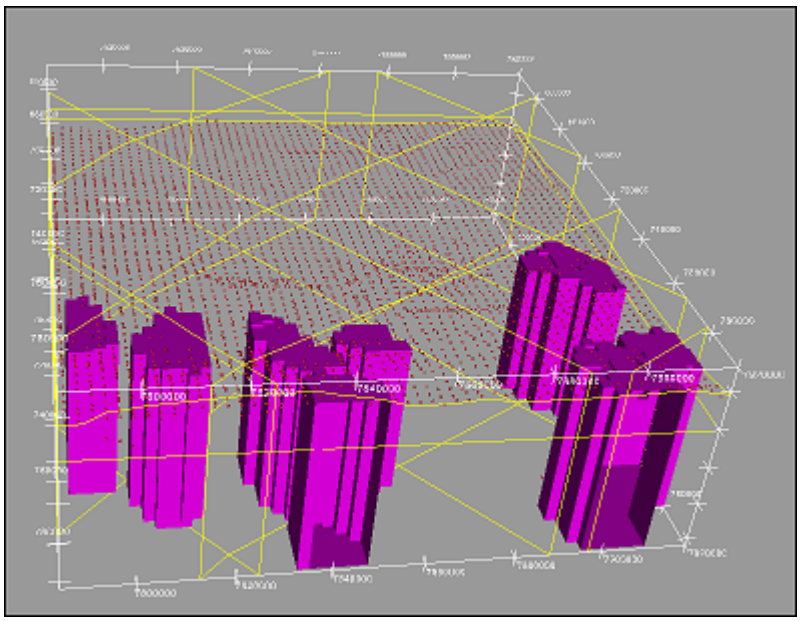
-
- The second example below outputs the Shell for Formation 3 in the .vtp poly format



- The third example shows the results of the two queries displayed in the 3D viewer. Points for top of Formations 1 and 2 (base of 3) and shell for Formation 2



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Mesh and Grid Field Interpolation

Parent topic: 3D GeoModeller Reference

In this section:

- Introduction to mesh and grid field interpolation
- Inverse Distance Interpolation
- Variogram Analysis
- Kriging
- Domain Kriging

Introduction to mesh and grid field interpolation

Parent topic: Mesh and Grid Field Interpolation

Interpolation by Inverse Distance, Kriging or Simulation

Based on the Meshes and Grids infrastructure, 3D GeoModeller provides a set of functions to interpolate, estimate and simulate variables in 2D or 3D space; the user can choose whether or not to constrain the kriging interpolators using the extents and properties of the geological model.

The interpolation functions take their input from a vertex mesh. This kind of mesh handles scattered datapoints with different values of measurements (fields). This mesh can be a 2D or a 3D mesh.

The interpolation output is stored in a regular 2D or 3D grid.

Concepts

Kriging results will be a 2D/3D grid with 2 fields (the interpolated measurements and the variance of the estimation). Inverse Distance output is just one field, the interpolated variable.

Prior to Kriging the user must do a variogram analysis of the selected field (in 2D or 3D). Then use the resulting variogram model to realize the estimation of the variable.

For the theoretical discussion refer to the Appendix A.

Functions

The main functionalities are:

- Interpolation (inverse distance).
- Structural analysis (variogram study) in 2D and 3D.
- Kriging 2D/3D using the variogram analysis.
- Domaining 3D (Kriging taking into account the geological model).
- Sequential Gaussian Simulation.

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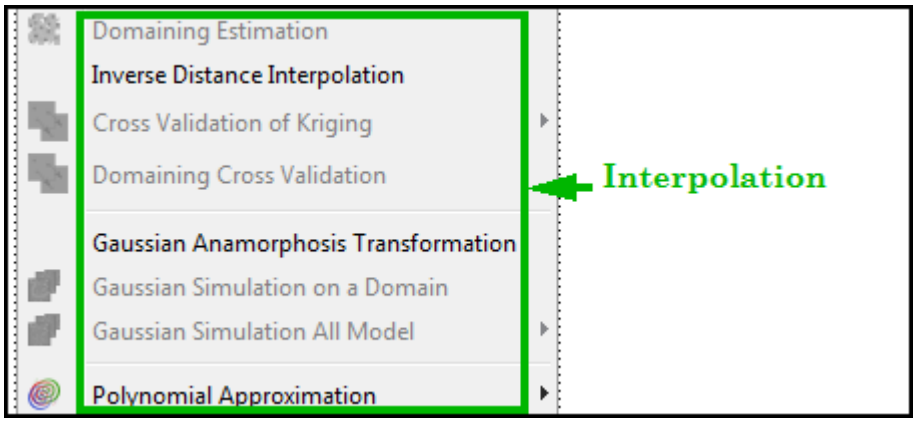
- **The Interpolation Menus**
  - The Fields context menu before variogram analysis



  - The Fields context menu after variogram analysis

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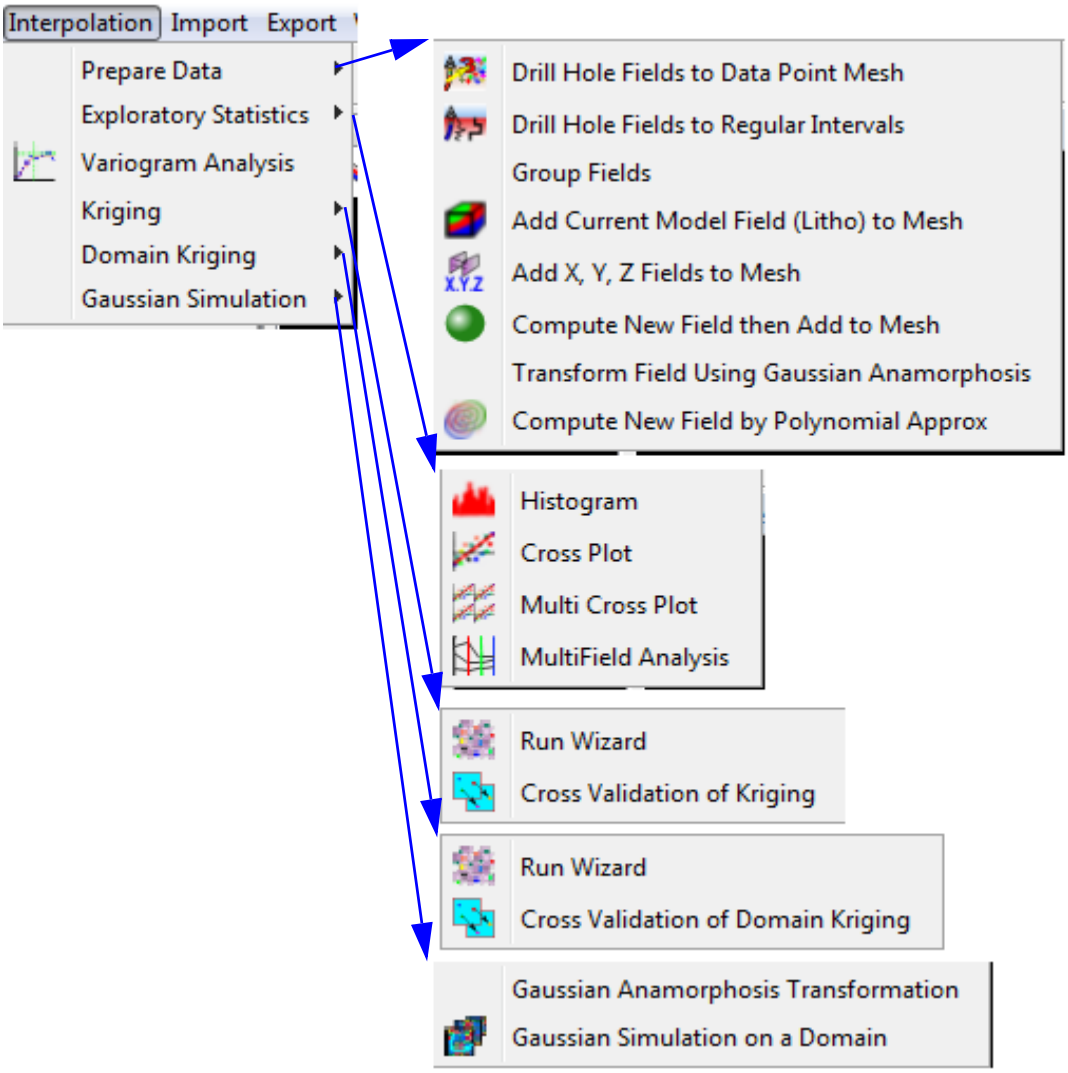
- Interpolation Functions can also be accessed from the main menu.



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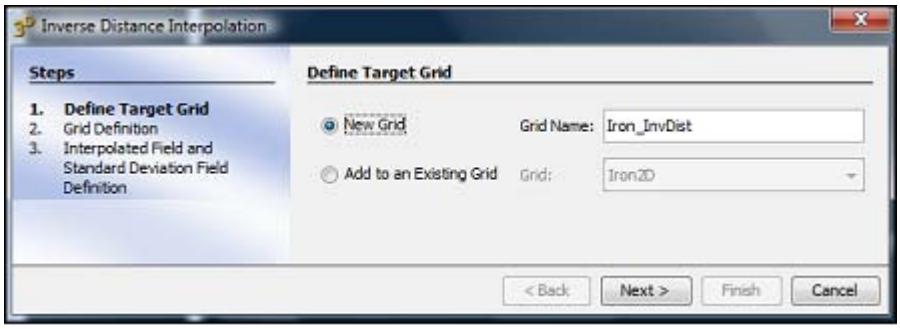
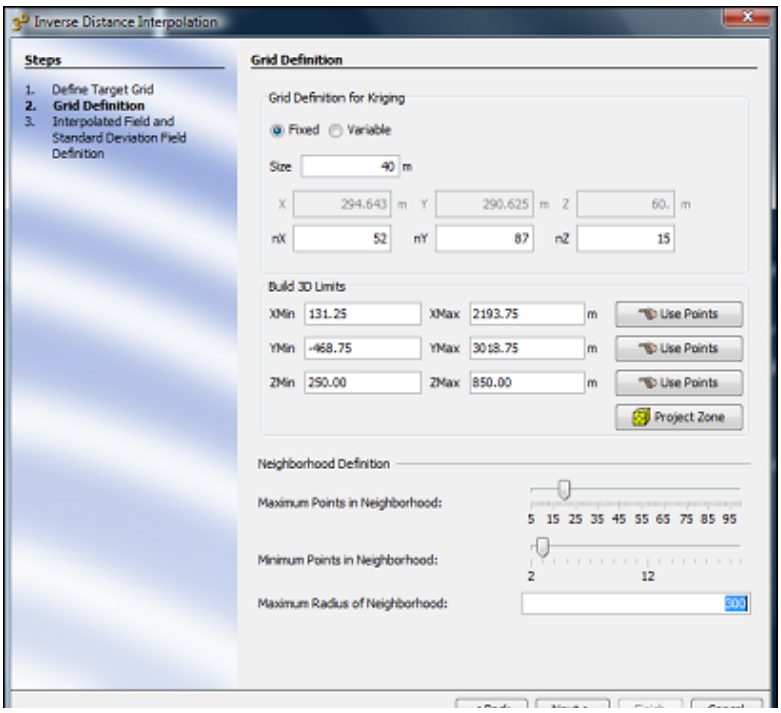
Inverse Distance Interpolation

Parent topic:
Mesh and Grid Field Interpolation

- The wizard contains four steps as shown in the next set of dialogs
  - **Step 1. Define Target Grid** - Select the target output grid
    - **New Grid** or
    - **Add to an Existing Grid**



  - **Step 2. Grid Definition** - Define the output grid resolution and extents and the neighbourhood search parameters
    - Fixed or variable cell size and the grid extents options are available in the top two panels.


Inverse Distance Interpolation
Steps
1. Define Target Grid
2. Grid Definition
3. Interpolated Field and Standard Deviation Field Definition
Grid Definition
Grid Definition for Kriging
Fixed
Variable
Size 40 m
X 294.643 m Y 290.625 m Z 60. m
nX 52 nY 87 nZ 15
Build 3D Limits
XMin 131.25 XMax 2193.75 m Use Points
YMin -468.75 YMax 3018.75 m Use Points
ZMin 250.00 ZMax 850.00 m Use Points
Project Zone
Neighborhood Definition
Maximum Points in Neighborhood:
5 15 25 35 45 55 65 75 85 95
Minimum Points in Neighborhood:
2 12
Maximum Radius of Neighborhood:
300

    - The Neighbourhood options are:
    - **Maximum Points in neighbourhood**: The algorithm does a radial search for points from the centre of the cell to be interpolated. It stops searching once the Maximum Points limit is reached.
    - **Minimum Points in neighbourhood**: The minimum number of points in the radial search required to calculate a value for the cell. If the minimum is not reached then the cell value is set to Null.

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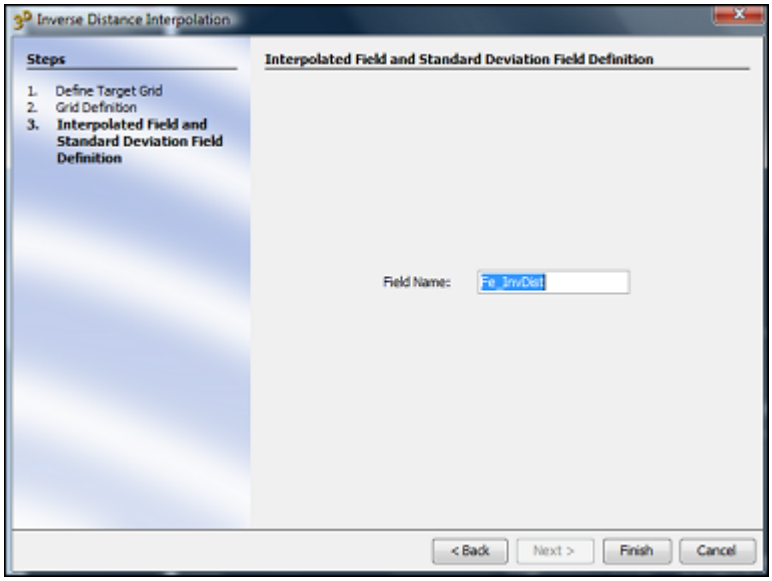
- **Maximum Radius of Neighbourhood:** The maximum radial search distance used to scan for points to include in the estimation of a cell value.

- **Step 3** Define a name for the new interpolated Field



Variogram Analysis

Parent topic: Mesh and Grid Field Interpolation

- Selecting variogram analysis opens a wizard which takes the user through the steps required to produce a sensible variogram model prior to running the kriging interpolators.
- The wizard contains four steps:
  - Selection of the variogram analysis type. The user can modify an existing analysis or create a new one. The analysis can be saved as an attribute of a field of a mesh of vertices. We define the maximum radius to compute the pairs for building the variogram and the coordinate space within which the variogram will be computed.
    - In 2D we can work in (x,y) or in r (sqrt(x^2 + y^2)).
    - In 3D we can work in (x,y); in this case we don't take into account the z coordinate) or
    - In r (sqrt(x^2 + y^2 + z^2)) - For the moment the (x,y,z) analysis user interface is not implemented and is turned off or
    - using the space coordinate of a potential, or
    - using the space coordinate of the potential plus curvilinear distance along the potential. .
  - Computation of the variogram
  - Analysis (Fitting of the variogram model)
  - Saving the analysis

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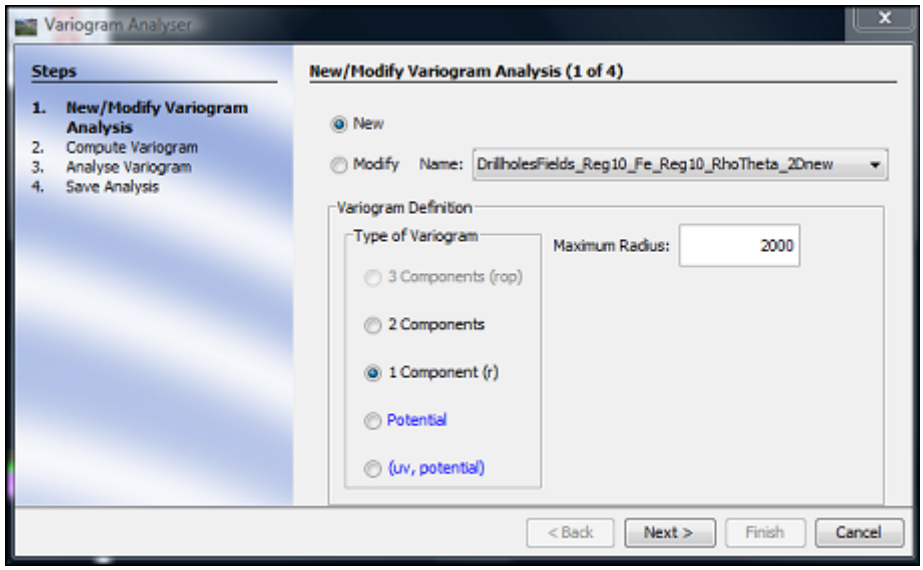
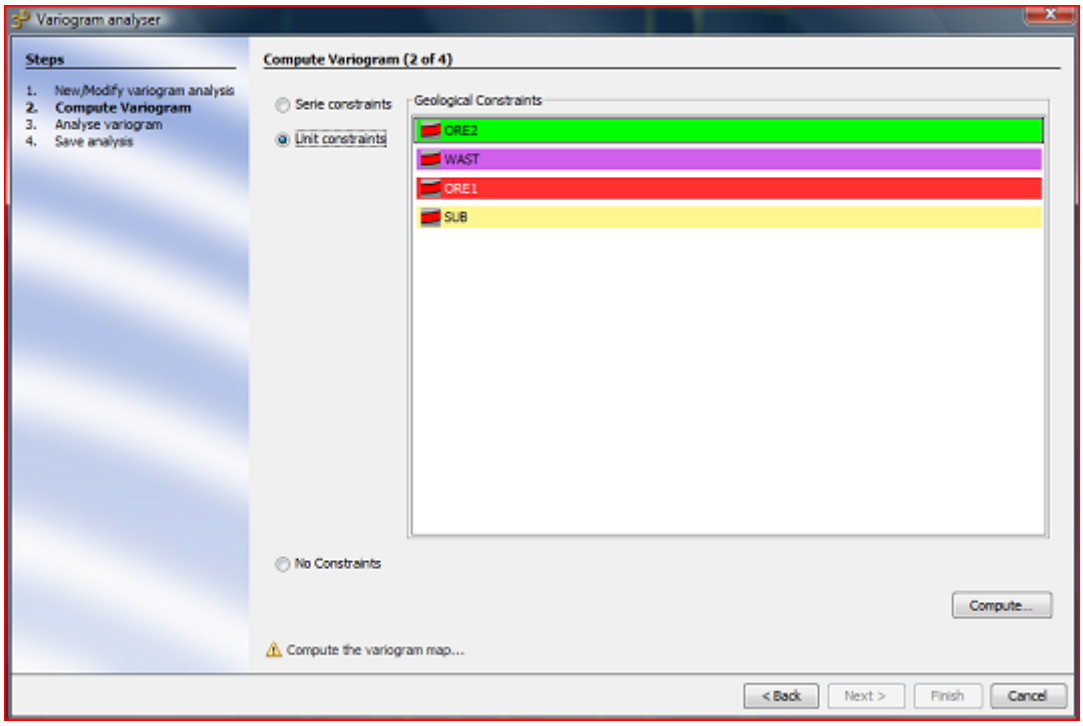
- **Step 1 - New Variogram Analysis**
  - Choose a new variogram analysis or modify an existing variogram model
  - Choose the variogram type
    - Two component variogram for modelling 2D anisotropy; only geometric anisotropy is supported (Sill fixed for both axes); available for 2D and 3D kriging and simulation.
    - One component variogram for isotropic data; available for 2D and 3D kriging and simulation.



- **Step 2 - Compute Variogram**
  - Choose the geological constraints for variogram modelling and Compute



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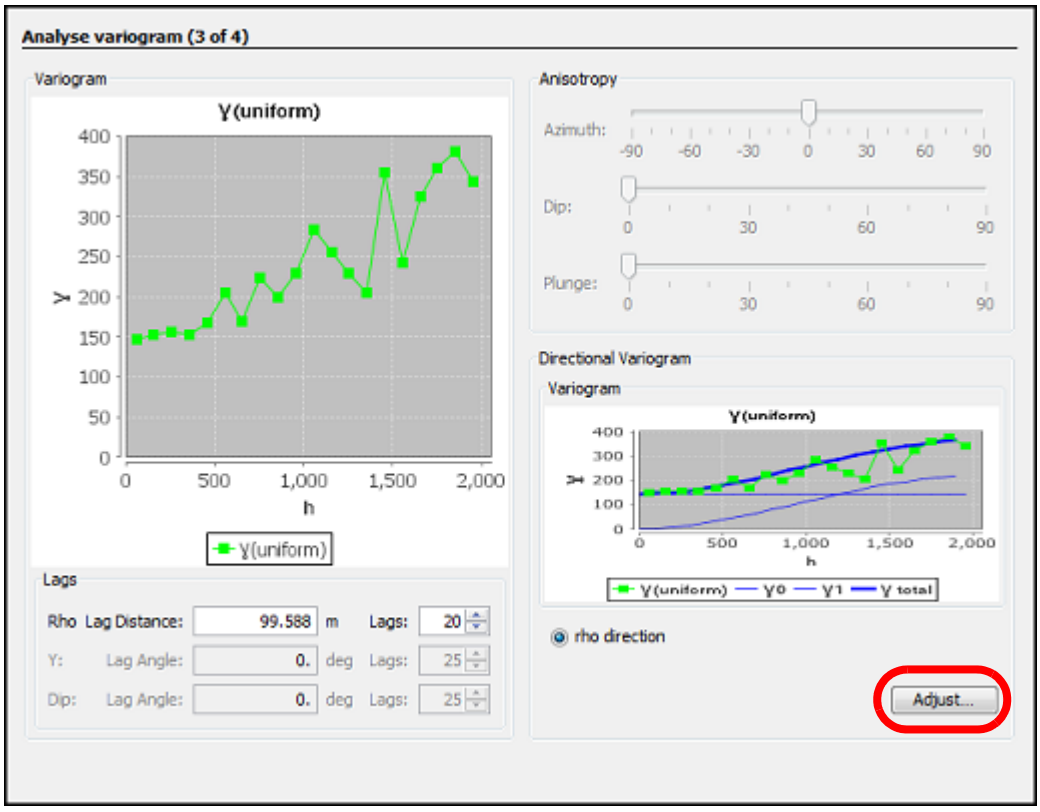
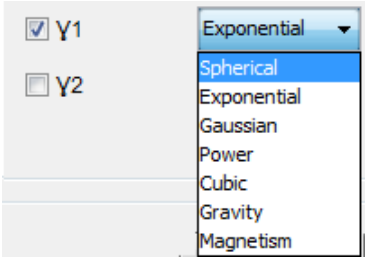
- Toggle **Series constraints** and choose one series only.
- Toggle **Unit constraints** and choose one lithological unit only.
- Toggle No constraints (All formations are modelled).

- **Step 3 - Adjust Variogram (1)**
  - Experiment with the number of lags to find a suitable data distribution for variogram fitting.



- **Step 4 - Adjust Variogram (2)**
  - The objective is to obtain a good quality fit to the data. If the data is erratic and a reasonable fit is not possible then re-examine your data distribution; if uneven then regularise or decluster. If the data exhibits a lognormal distribution transform to log space ie susceptibility. If nothing works then there may be very little spatial correlation and inverse distance will be the best solution.
  - To Fit a variogram curve click the **Adjust** button (red highlight) and proceed as follows.

    a. Choose a variogram model type from the drop down list.



Examples of the most common variogram models are illustrated below.

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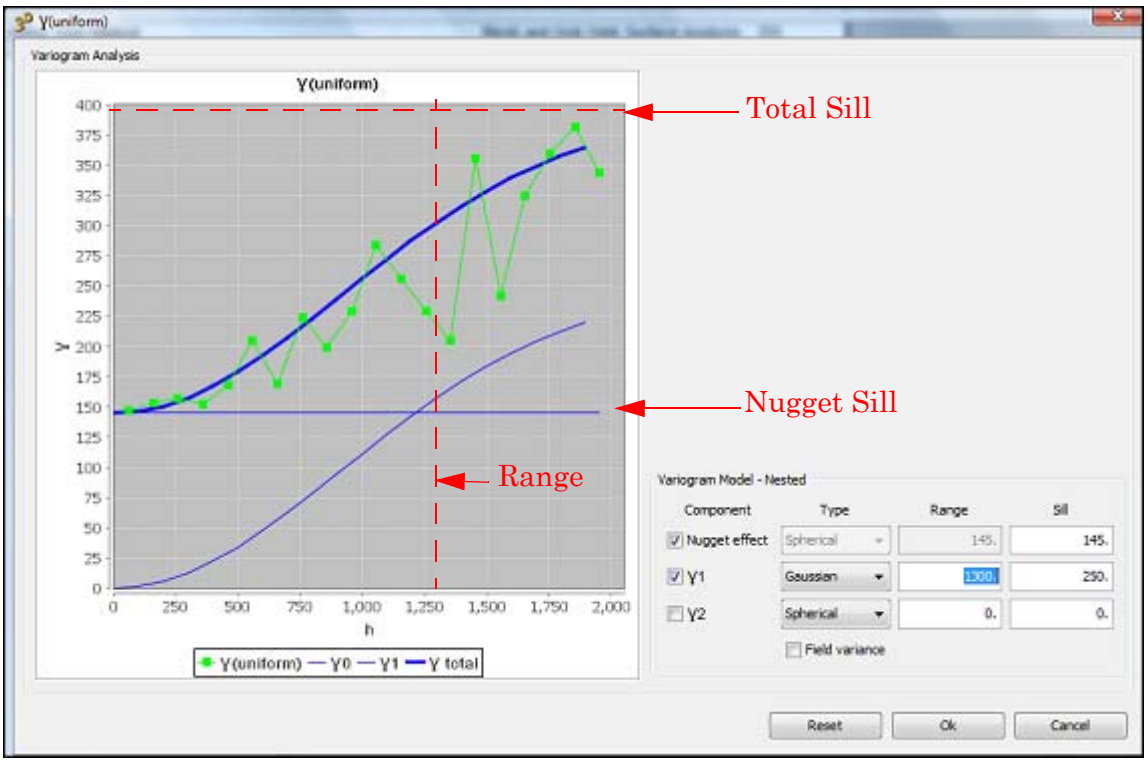

b. Toggle **Nugget effect**; enter *Sill* value where curve intersects Y axis.

c. Toggle ***y1*** and enter *Range* (h) value where curve levels out (X axis), then enter the *Sill* (y) value (Y axis intercept) where the curve levels out (**spherical**) or reaches the mid inflexion (**gaussian**). See model examples below.

Model sill values are cumulative so enter the ***y1*** Sill as:
y1 Sill = (Total Sill - Nugget Sill)

If there are problems with the fit, experiment with other variogram models (distributions).

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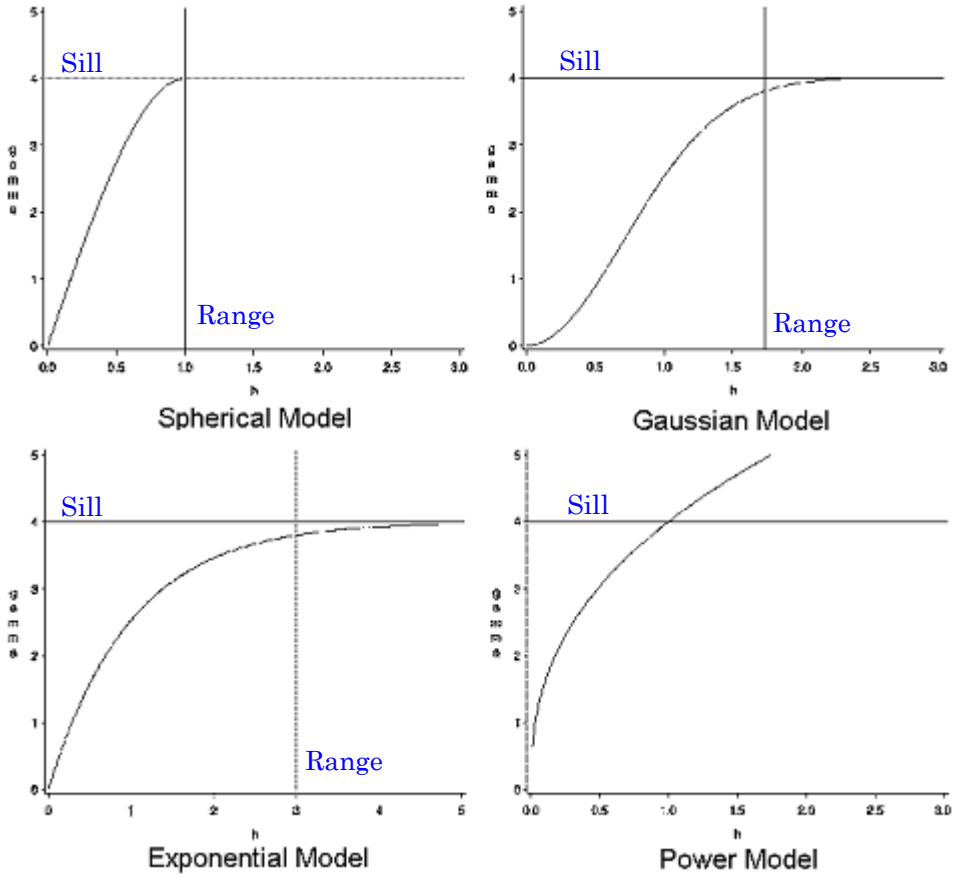
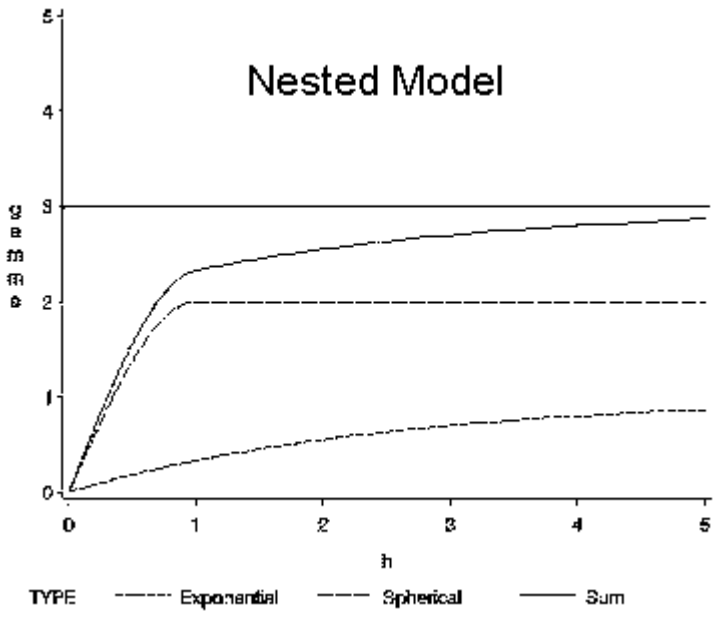
- Examples of the most common variogram model types are illustrated below.



- **Nesting**: It is possible to handle complex distributions where there is more than one model distribution in the data by using a nested model. The user would handle this by toggling *y2* and trying to fit a second distribution which when added will give a better fit to the observed data. A nested model example is shown below.



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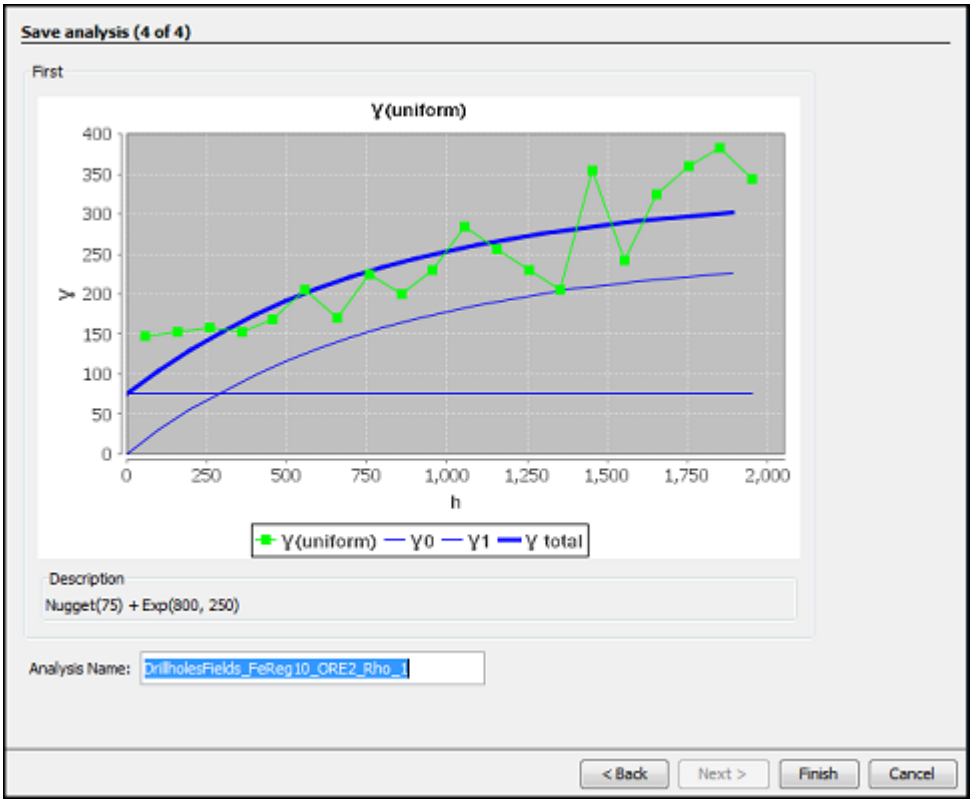
- **Step 5 - Save As**
  - Save the variogram model with a suitable name. A default name is built from the input field, formation and variogram model type.The user can accept or edit the name.



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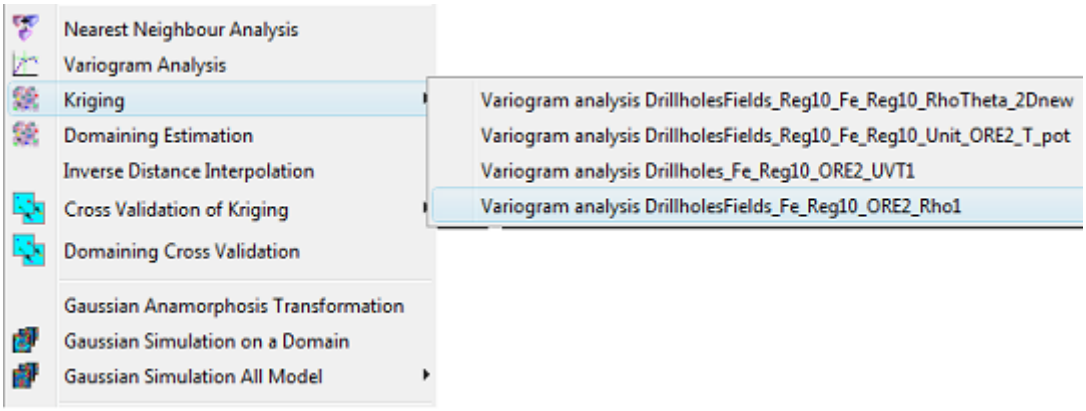
Kriging

Parent topic:
Mesh and Grid Field Interpolation

- Now that we have produced an isotropic variogram model as described in the section above. The Kriging interpolation option can be selected in the field context menu.
- Right Click on Kriging in the Field context menu and select the variogram that you saved during variogram analysis.



-
- **Step1. Define target grid**
  - Choose **New Grid** -and type a new grid name or
  - Choose **Add to an Existing Grid** and select from the list of existing grids with the desired characteristics ie cell/voxet size and extents. The Kriging result will be written to the existing grid in a new field.

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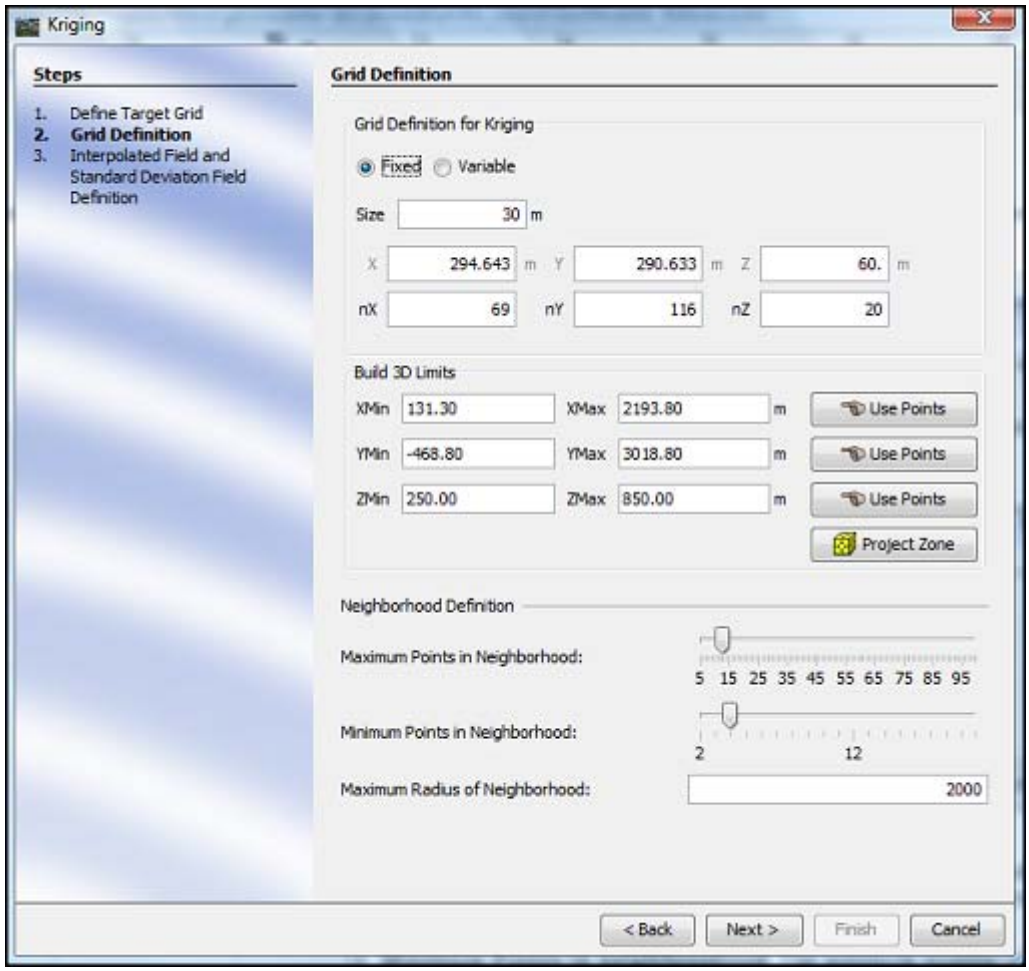
- **Step 2. Grid Definition** - Define the output grid resolution and extents and neighbourhood search parameters
  - **Grid Definition for Kriging** - Define output grid fixed or variable cell sizes or the number of grid cells in the X ,Y & Z directions in the top panel.
  - **Build 3D Limits** - Interpolate a subset of the 3D GeoModeller project by entering new X, Y, Z min/max limits or accept the default of the full project area. The project extents can be reset by clicking on the **Project Zone** button.
    - **Use Points** - You can use points digitised on a section in the 2D Viewer or captured in the Points list editor to set the X, Y, Z min/max limits by clicking on the **Use Points** buttons.



- **Neighbourhood Definition** options are:
  - **Maximum Points in neighbourhood**: The algorithm does a radial search for points from the centre of the cell to be interpolated. It stops searching once the Maximum Points limit is reached.
  - **Minimum Points in neighbourhood**: The minimum number of points in the radial search required to calculate a value for the cell. If the minimum is not reached then the cell value is set to Null.
  - **Maximum Radius of Neighbourhood:** The maximum radial search distance used to scan for points to include in the estimation of a cell value.

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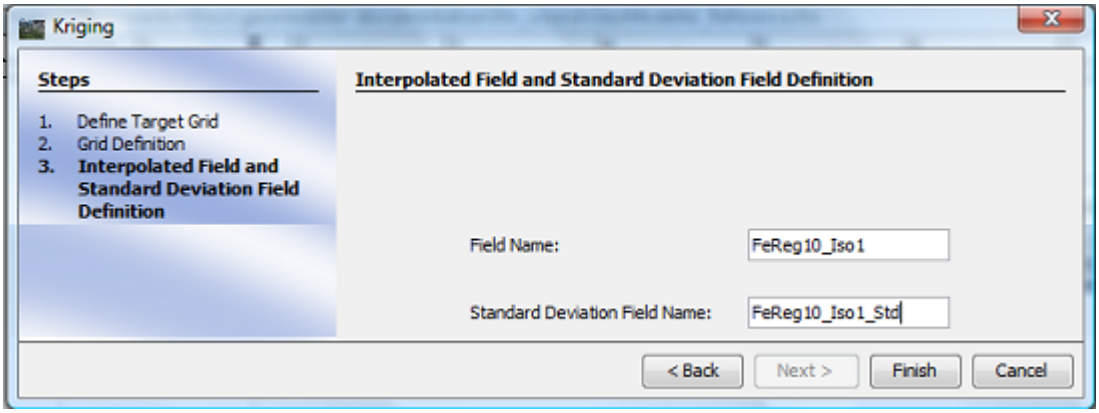
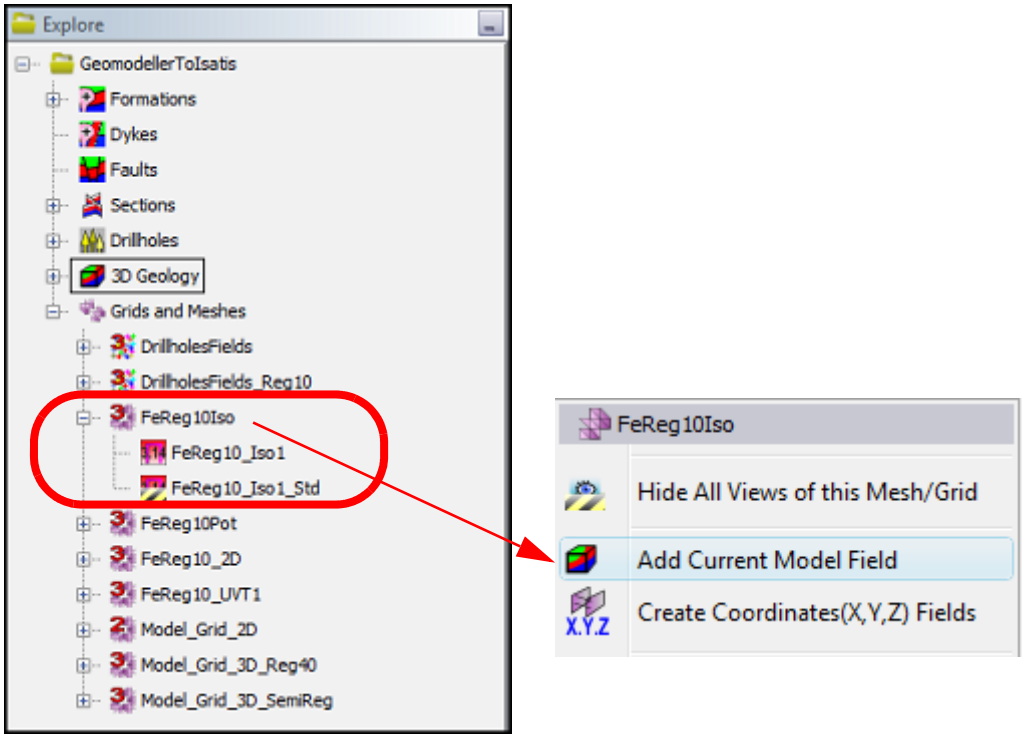
- **Step3 - Define field names** for Kriged and Kriged StdDev outputs.
  - Click **Finish** button to run the interpolation
  - The output grid will be available for visualisation in the Grids and Meshes section of the **Explore** tree as shown in red highlight below.





Note: Although we defined the isotropic variogram using the formation ORE2 only, the Kriging function has used the criteria defined in Step2 to interpolate the whole project neighbourhood and not just the formation ORE2. The Domain kriging functions are the only geostatistical operations that can be constrained to interpolate within a single series or formation in this version of 3D GeoModeller.

The isotropic kriging results grid can be masked to a single formation/unit by following the post interpolation procedure outlined below.

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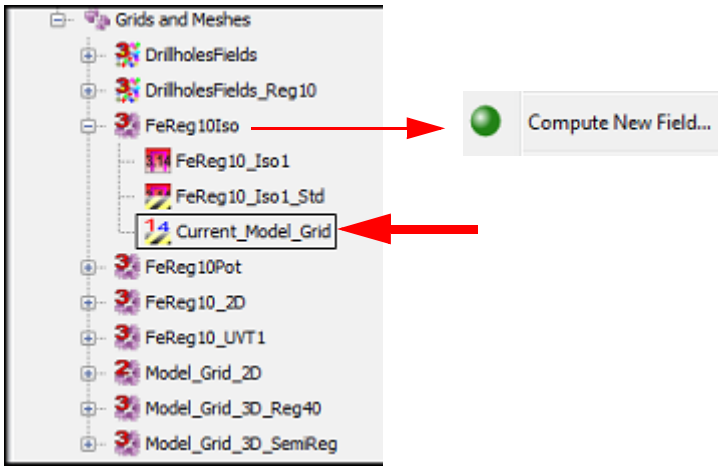
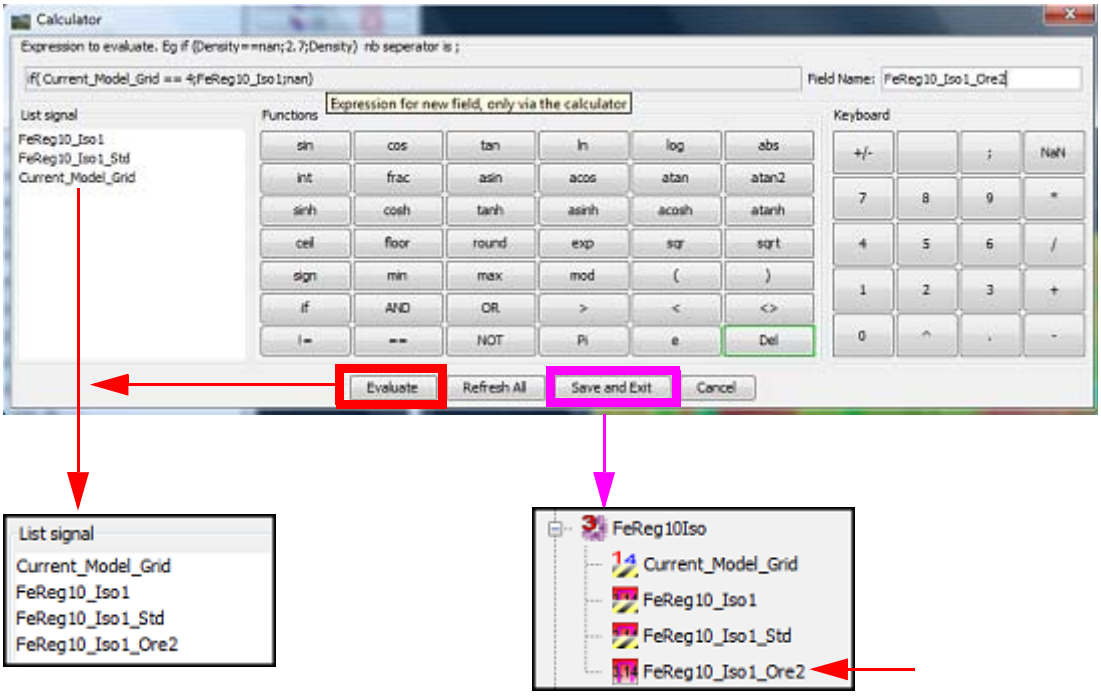
- Masking a 3D grid using one or more formations
  - Add the 3D Model to your kriged grid FeReg10Iso
    - Right Click on grid *FeReg10Iso* and select **Add Current Model Field** as shown above.
    - The current model lithology is added to the grid as a new field (arrowed below).



    - Right Click on grid ***FeReg10Iso*** and select Compute New Field as shown above.
    - The Calculator opens. Create formula below using the calculator buttons.
      - *if(Current_Model_Grid = = 3;FeReg10_Iso1;Nan)*
    - Type in the new grid Field Name: ***FeReg10_Iso1***
    - Click **Evaluate**; wait for new variable to appear in **List signal** column
    - Click **Save and Exit;** Grid field list updates.



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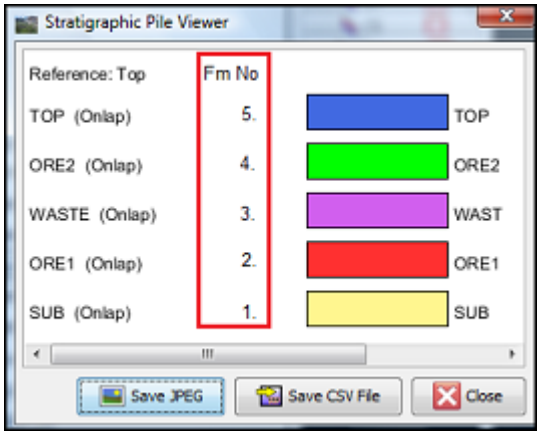
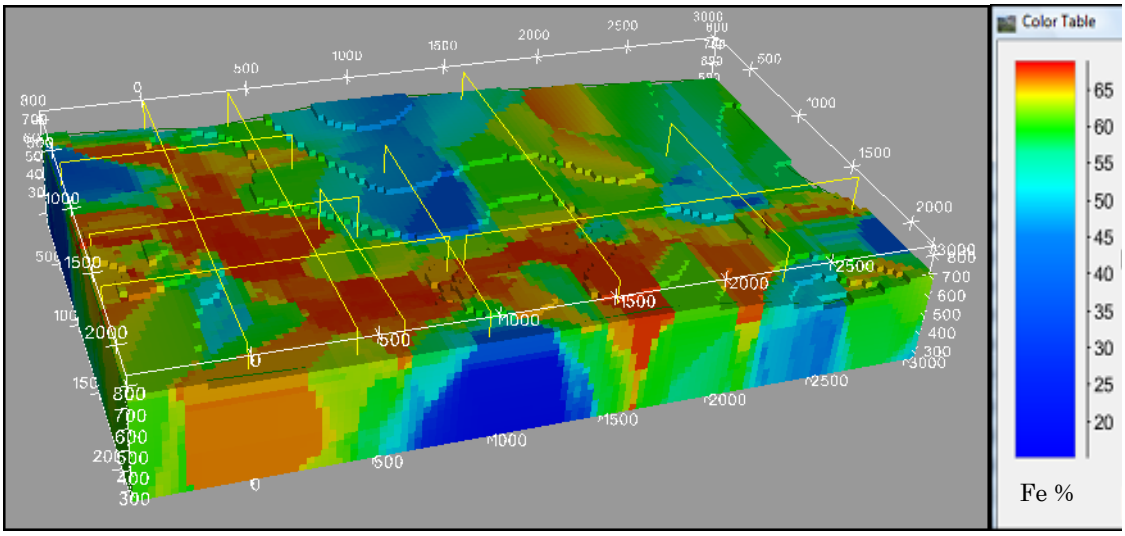
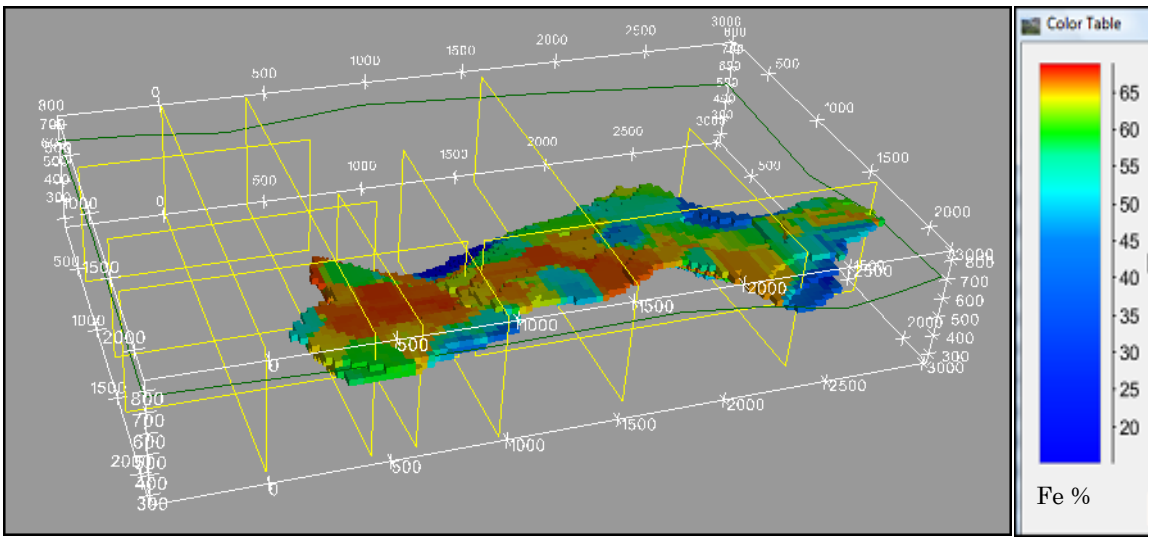
- The formation/lithology index numbers are assigned from the bottom of the Pile upwards as shown below in the red box.



- Unmasked (All formations) - 3D view of the Isotropic kriging result below



- Masked (ORE2) - 3D view of the Isotropic kriging result below.



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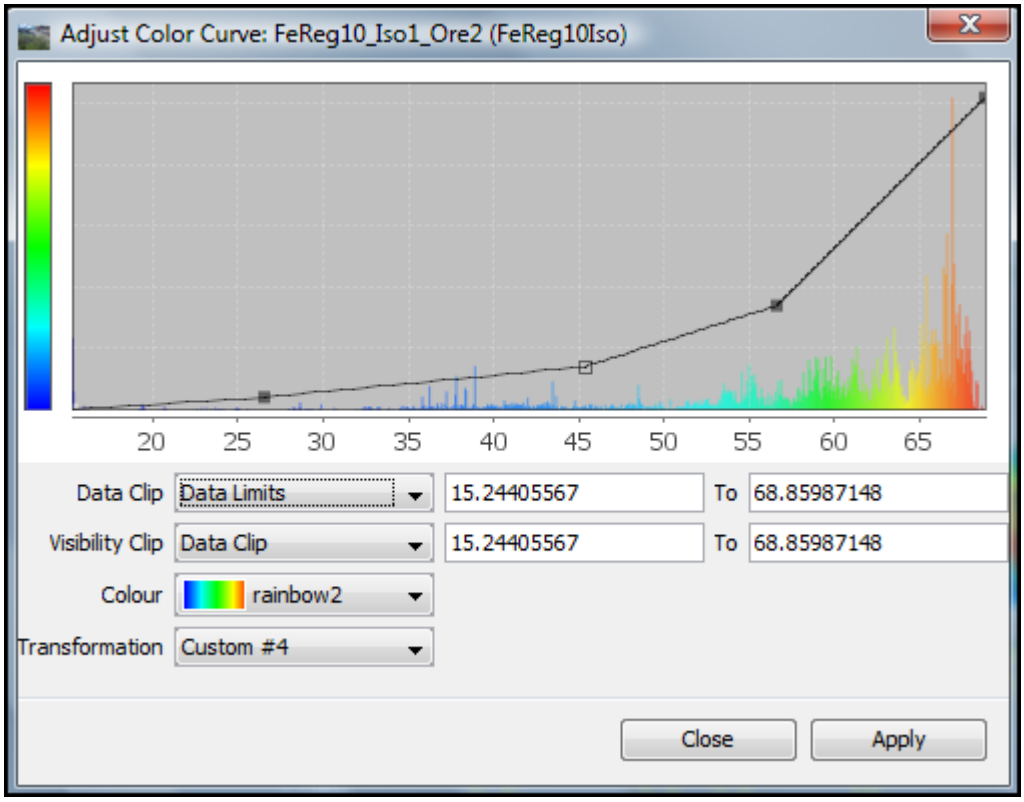
- Colour LUT Tool showing colour stretch for the above two 3d views with colour bar scale showing values in Fe%



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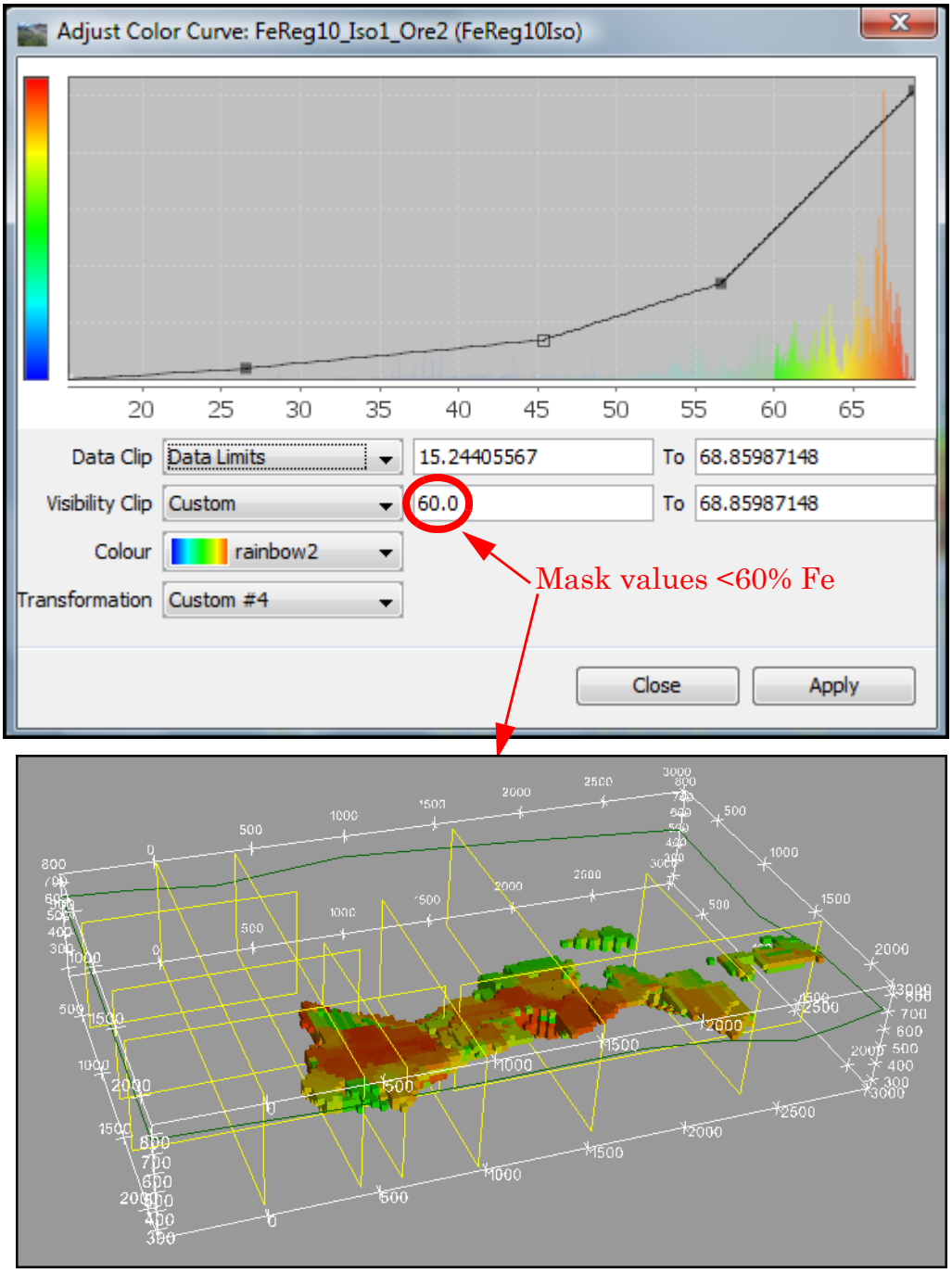
- Colour LUT Tool and 3D view showing the Fe values masked below 60% Fe



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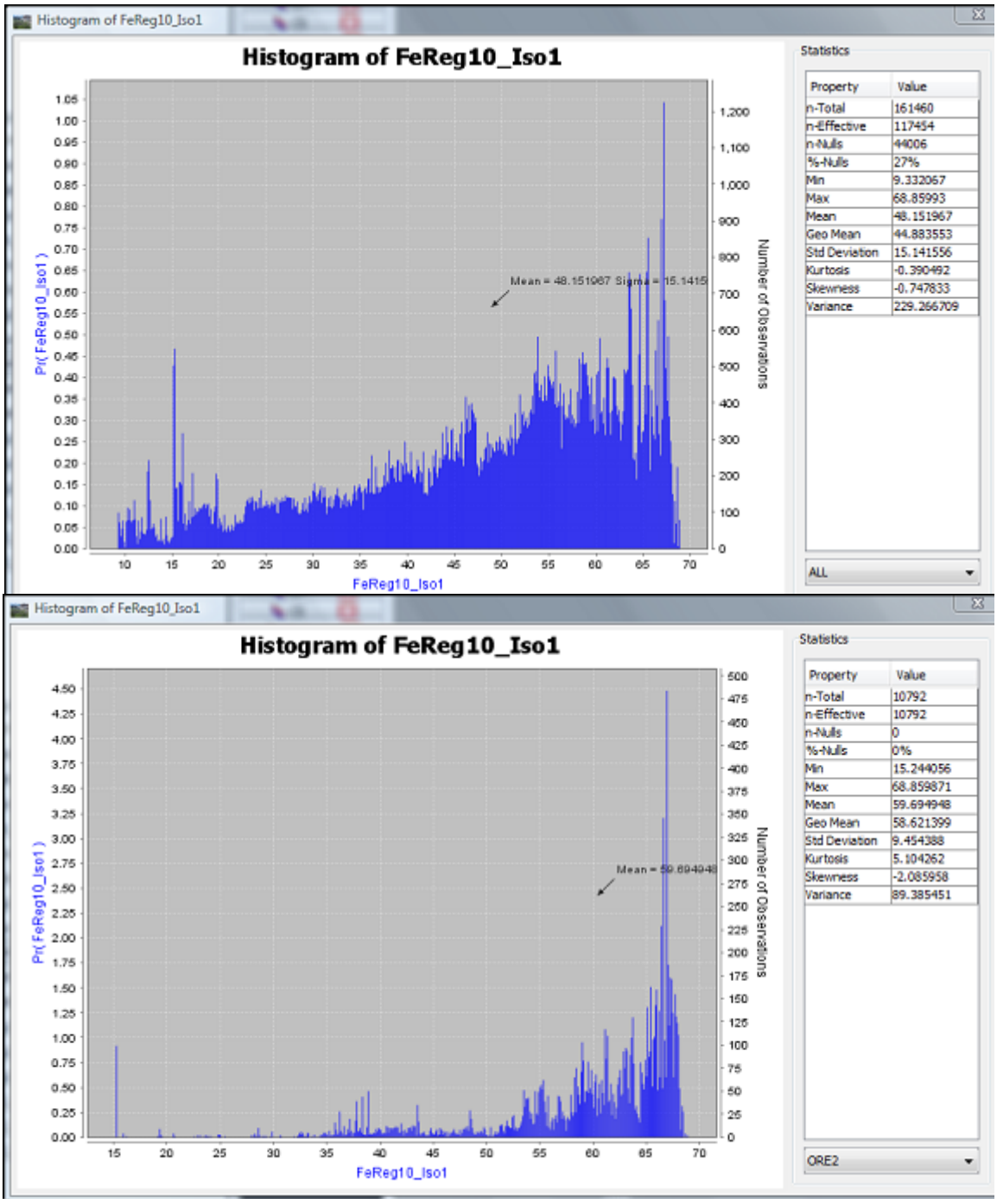
- Histograms of the isotropic kriging result for all formations and for the ORE2 formation alone using the drop down formation menu. This menu is available when the Lithology field is available in the grid.



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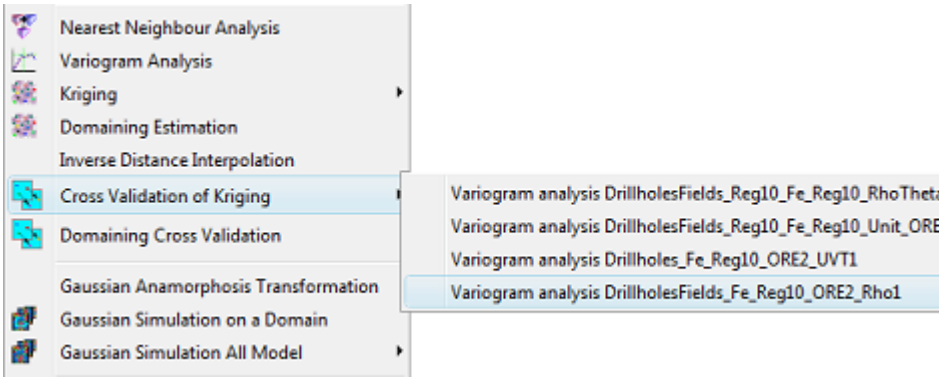
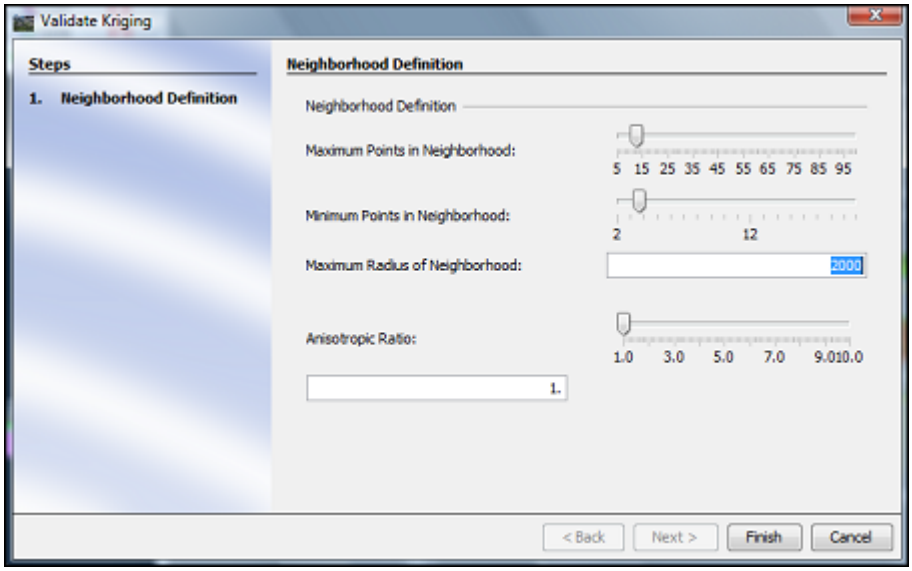
- **Cross Validation of Kriging**
  - The degree to which the isotropic kriging interpolation honours the observed data can be evaluated using cross validation scatter plots and linear regression
  - Right Click on the *Fe_Reg10* drillhole data points field and select **Cross Validation of Kriging**
    - Select the isotropic (Rho) variogram for validation



    - Select the same neighbourhood options as those used in the isotropic kriging interpolation



    - A scattergram of the original observations plotted against the isotropic kriging interpolation results is generated. The scattergram points are colour coded by formation and the result illustrates the poor fit resulting from the kriging of all the values using the variogram generated from the ORE2 formation only.

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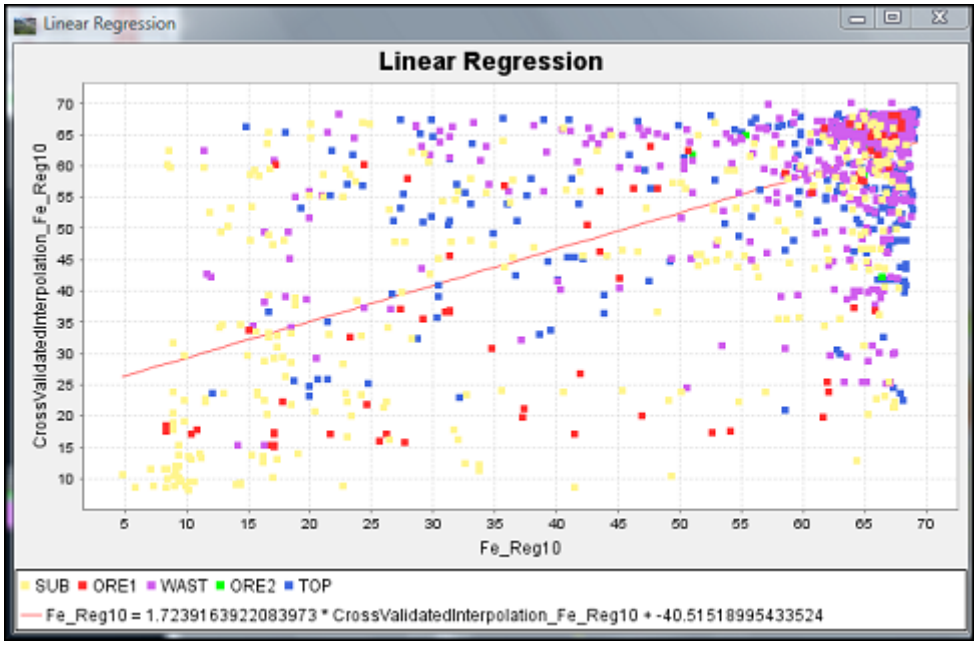

Domain Kriging

Parent topic: Mesh and Grid Field Interpolation

- The following section provides a theoretical overview of the two Domain kriging algorithms available in GeoModeller. This section is followed by an example and a description of the variogram modelling and kriging dialogs used in these operations.

Abstract

Estimation of a variable related to a geological unit can be done using geostatistical methods. To solve the problem we need to define a ”geological distance” since each geological phenomenon can have an anisotropic variogram. For example, the variogram of a sedimentary ore body has a larger range along the stratification than in the direction perpendicular to the stratification.

We define a space coordinate that takes into account the shape of the geological unit. A good knowledge of the geology can give a natural coordinate system. For example, imagine an event folding a geological unit; in this case the distance used for the kriging will no longer be the euclidian distance, d(x,y,z), but a distance that must take in to account the folding. One solution is to unfold the unit and use the Euclidian distance in the unfolded space. Alternatively if we have an equation that describes the folding we can use this equation to compute the distance, and we don’t need to use the unfolding procedure.

We will illustrate this technique using the potential field describing the geological unit shapes.

Introduction

One major problem reservoir or mine geologists often encounter in geologic modelling, resource estimation or simulation is how to interpolate the petrophysical and chemical properties (porosity, permeability and grades) in a geological model while taking into account the geometry and history of the geological units.

One reason for creating 3D models is to use them for 3D simulation (geophysical, fluid flow, mechanics) or estimation of resources (grade, heat). For this purpose, filling the

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model with petrophysical properties is a prerequisite. There is a long tradition of using geostatistical interpolation methods for interpolation in the geosciences, (Chilès, J.P., Delfiner, P., 1999). These techniques are all based on the computation of a distance, in general the Euclidian distance for the geosciences. The traditional way to realize a geostatistical study in 3D is (1) to compute a 3D variogram and (2) to estimate by kriging the value of the petrophysical property in each cell of a 3D grid. Both calculations require computing the Euclidian distance between data points and between the grid cell and data points where the petrophysical property has been measured (for example in different boreholes).

In case of "simple geology", such as sub horizontal layer cake models, the Euclidian distance d(x,y,z) is computed from the Easting, Northing and Elevation coordinates. This is a good estimator of the "geological" distance because there is little or no deformation of the 3D space. However this approximation is not suitable in more complex geology (folding, faulting). To solve this problem some authors propose to work in the undeformed (unfaulted and unfolded) space of the geology (Mallet 2004, Jayr et al. 2008) or to build "stratigraphic grids", grids that are conformal with geological boundaries, (Bertecello et al. 2008). Despite their elegancy, these methods show some limitations in case of complex geometries (fault reverse fault, overturned units). They rely on the hypothesis that an unfaulting/unfolding or grid building process is effectively possible.

Alternatively, if the formulation of the modelling method allows computation of "geological distances", kriging of properties can be directly performed by using this distance in the variogram calculation.

We propose a method that relies on the description of the shapes of the geological formations with implicit potential functions (Lajaunie et al. 1997, Calcagno et al 2008). We will see how these functions are used (value and gradient) to define a new space where distance computation takes into account the internal geometry of the geological units. These functions are based on the data belonging to a unit such as:

- 3D points on the unit interface
- Structural data (direction, dip) of the unit.

In this method the implicit function is a potential field function (laplacian of the function equals zero) and each unit is represented by this kind of function. We know everywhere in the space this function and its gradient. At the same time we will see how we can forget the idea of a grid, the grid will be an implicit grid, and the technique can be used to fill the petrophysical properties using either an hexahedral grid or tetrahedral meshes.

Classical Kriging

In classical geostatistics to realize kriging of a variable inside a geological unit or a geological series (set of conformable units) there are three main possibilities:

- Kriging using 3 coordinates *(x,y,z)* or polar coordinates (ρ,θ,ψ), allowing the study of anisotropy in 3D, the three directions (*x, y, z*).
- Kriging using only 2 coordinates, polar coordinates (ρ, θ), limiting the study of anisotropy to 2D, the plane XY.
- Kriging using only 1 coordinate (ρ), where the study of anisotropy is not possible.

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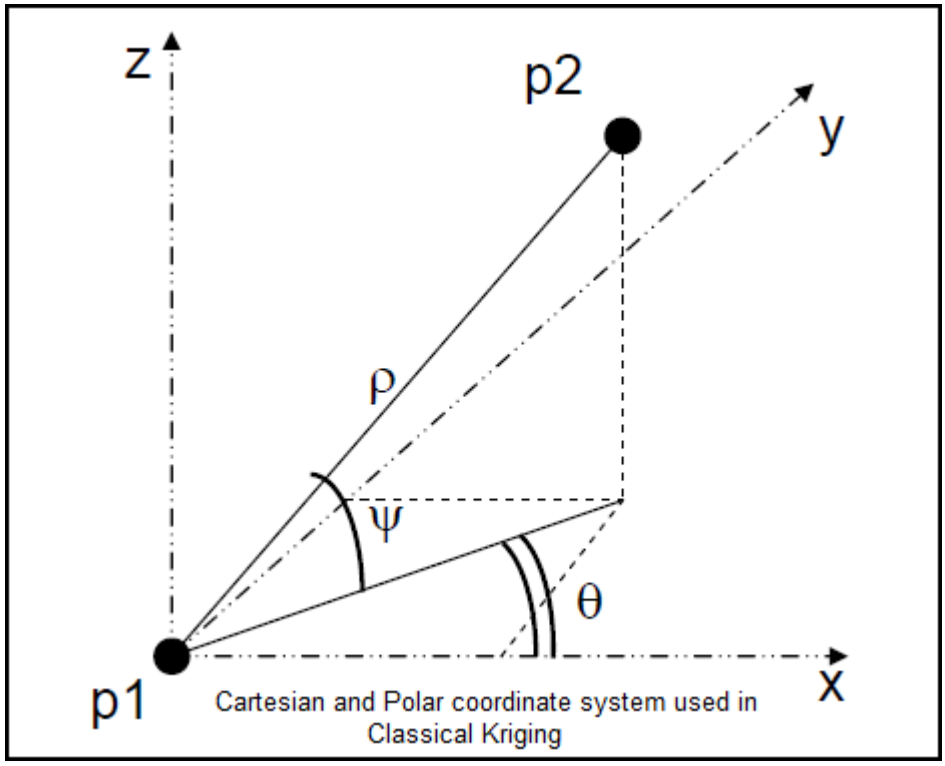

To enable kriging to take geology into account, we will compute the semi-variogram $\gamma(\rho)$ using pairs of points belonging to the same geological unit or geological series. In this case $\gamma(\rho)$ is defined by:

$$\gamma(\rho) = 1/2N(\rho) * \sum_{i=1}^{N(\rho)} [z(p_i) - z(p_i + \rho)]^2 \quad (1)$$

Where:

- $\boldsymbol{z(\rho_i)}$ represents the value of the variable to estimate at a point ρ_i and
- $\boldsymbol{z(\rho_i + h)}$ is the value of the variable of a point at distance $\boldsymbol{h}$ from point ρ_i.
- $\boldsymbol{N(\rho)}$ is the number of point pairs separated by a distance $\boldsymbol{h}$.

Space definition *(pot, dg, θ)*

Calcagno et al. (2008) have applied an implicit method based on potential field functions in order to model geological bodies using the location of the geological interfaces and orientation data from structural field, These functions are obtained by a dual co-kriging of equi-potential data (geological interfaces) and their gradients (orientations) (Lajaunie et al. 1997). The combination and truncations of these functions in a geological model allows a full description of geological shapes. Moreover, each geological formation can be assigned to a potential field in order to define its internal geometry, given these functions this geometry is represented inside formations as a set of iso-potential values (Figure. 2).

Walking on an isopotential between 2 points, A and B along the shortest path we will define a coordinate pair ***(dg, θ)***, where the coordinate ***dg*** represents the geodesic distance between A and B along this shortest path, and θ the azimuth of this walk. The coordinate normal to these isovalues will define a ***pot*** coordinate; we call it ***pot***

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because it represents the value of the potential field function.

The ***(dg, θ)*** coordinate is in this case the distance between 2 points along an isovalue of the potential field (geodesic distance) and θ is the azimuth of the section. Using the azimuth θ is a way to study the anisotropy in the plane XY, using only the ***dg*** coordinate and not θ, we use the hypothesis of isotropy in the XY plane.

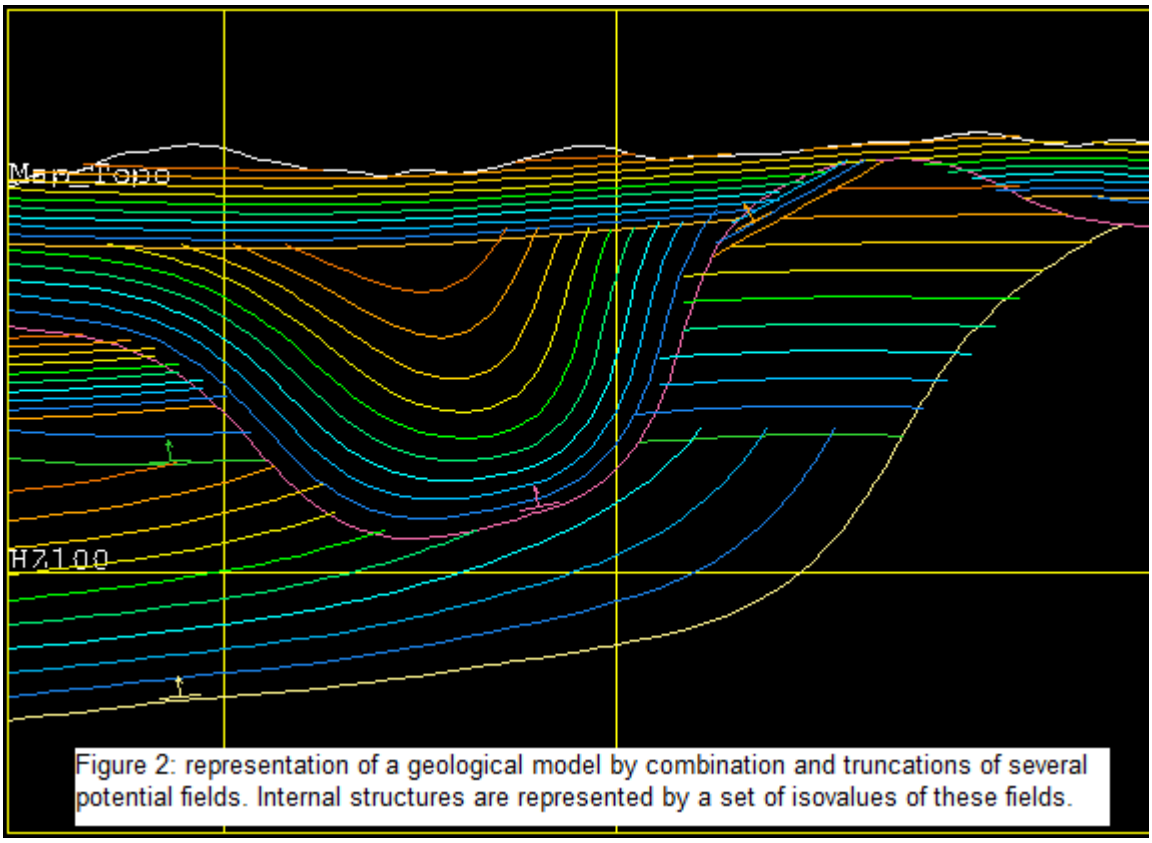

Figure 2: representation of a geological model by combination and truncations of several potential fields. Internal structures are represented by a set of isovalues of these fields.

Computing distance

When the two points ***A*** and ***B*** are on two different isovalues of the potential field; for example ***potA*** and ***potB***; there are two ways to define the ***dg(A, B)*** coordinate.

- We can define ***dg(A, B)*** as the distance along the isovalue ***potM*** where:
  - ***potM = (potA + potB)/2.***
- If we call ***Am*** the projection of the point ***A*** on the isovalue ***potM*** and ***Bm*** the projection of the point ***B*** on the isovalue ***potM***. We can define ***dg(A, B)*** as the value
  - ***dg(Am, Bm)***.

Alternatively if we call ***Ab*** the projection of the point ***A*** on the isovalue ***potB*** and ***Ba*** the projection of the point ***B*** on the isovalue ***potA***

- We can define ***dg(A, B)*** as the mean of the two distances
  - ***dg(Ab, B)*** and ***dg(A, Ba)***.

The first solution needs the computation of two projections and one distance along an isovalue, the second one needs the computation of two projections and two distances along two isovalues.

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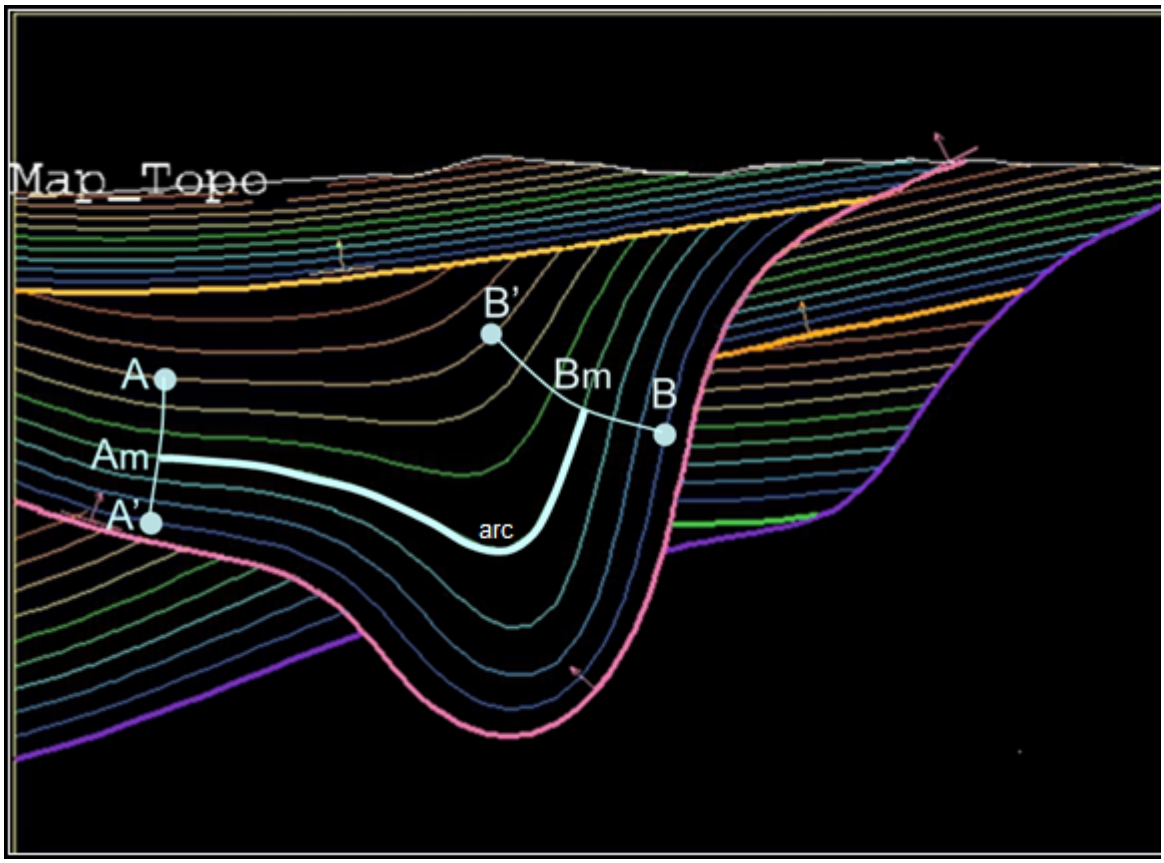
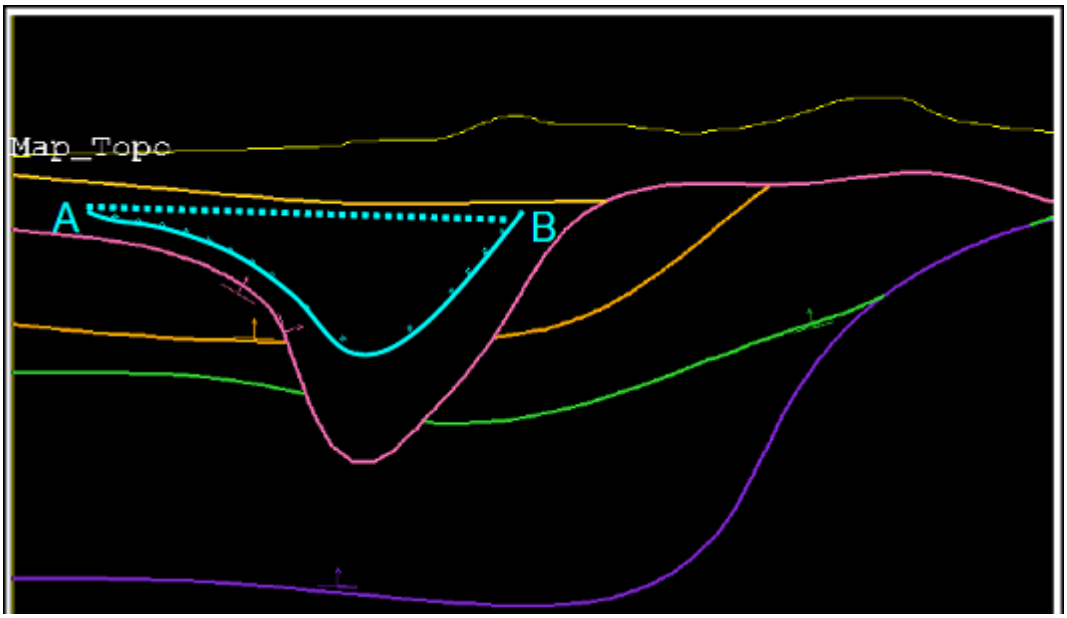
Here we will work on the first solution, which requires less computation time. The next figure illustrates how we compute the distance in the ***(pot, dg, θ)*** space.

The point ***A*** is on isovalue ***potA***, the point ***B*** on isovalue ***potB***. The distance ***dg(A, B)*** is the length of the arc (label) at isovalue ***potM = (potA + potB)/2***. The distance along the coordinate ***potM*** is ***dg(Am, Bm)***. Thus we define ***dg(A,B)*** = ***dg(Am, Bm)***.



dg(A, B) **distance:**

To compute distance we use the gradient of potential field to walk on the isosurface in 3D space. The algorithm to compute distance is defined in the following 2D figure.



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If the points ***A*** and ***B*** belong to an isovalue ***V***, the dashed line connecting the point ***A*** to point ***B*** is projected onto this isovalue using dichotomy. We compute a point C at the middle of line ***AB*** then we project ***C*** using the gradient of the isopotential on to isopotential ***V***. If the new length ***AC + CB*** is much less than the length ***AB*** we split the chord ***AC*** to obtain ***D*** and the chord ***CB*** to obtain ***E*** and we project ***D*** and ***E*** on to isopotential ***V*** and so on until the new length doesn't change more than a few percent from the former length ***AB*** . In this example the length of ***AB*** at the start is 3551m after the projections the length is 4541m.

***pot* Distance:**

Computation of ***pot*** distance between two points ***A*** and ***B***, ***pot(A, B)*** is very easy; it is the absolute value of the difference between ***pot(A)*** and ***pot(B)***.

Variogram *(pot, dg, θ)*:

It is necessary to recall some features that can be expected using a multi coordinate variogram:

- Geometric anisotropy: range changes with direction while sill remains constant.
- Zonal anisotropy: sill changes with direction while range remains constant.
- To deal with changes of range and sill with direction, we need to identify the anisotropy axes, using variogram surface maps or knowledge of the phenomenon.

Here the distances ***dg*** and ***pot*** are two different distances, and they are not comparable, so one solution is to normalize them by the range.

In many cases if we ignore θ, then ***γ(pot,dg)*** will present a combination of geometrical and zonal anisotropy:

$$\begin{aligned}\gamma(pot,dg) \;=\;& C_0^{pot} + (C_0^{dg} - C_0^{pot})\,\mathbf{Mod}(pot/r_{pot}, dg/\varepsilon) \\ &+ (C_0^{pot} + C^{pot} - C_0^{dg})\mathbf{Mod}(pot/r_{pot}, dg/r_{dg}) \\ &+ (C_0^{dg} + C^{dg} - (C_0^{pot} + C^{pot}))\mathbf{Mod}(pot/\infty, dg/r_{dg}) \\ \gamma(pot,dg) \;=\;& C_0^{pot} + (C_0^{dg} - C_0^{pot})\,\mathbf{Mod}(pot/r_{pot}, \infty) \\ &+ (C_0^{pot} + C^{pot} - C_0^{dg})\mathbf{Mod}(pot/r_{pot}, dg/r_{dg}) \\ &+ (C_0^{dg} + C^{dg} - (C_0^{pot} + C^{pot}))\mathbf{Mod}(0, dg/r_{dg})\end{aligned} \qquad (2)$$

Where:

- $Mod(x,y) = Mod\left(\sqrt{x^2 + y^2}\right) = Mod(h))$
- C_0^{pot} is the nugget effect, C^{pot} is the sill value, ***pot*** is the distance along the coordinate potential and r_{pot} is the range of the model **Mod** for the component ***pot***.
- C_0^{dg} is the nugget effect and C^{dg} is the sill value, ***dg*** is the distance along the coordinate potential and r_{dg} is the range of the model **Mod** for the component ***dg*** .

Here is an example of such a variogram

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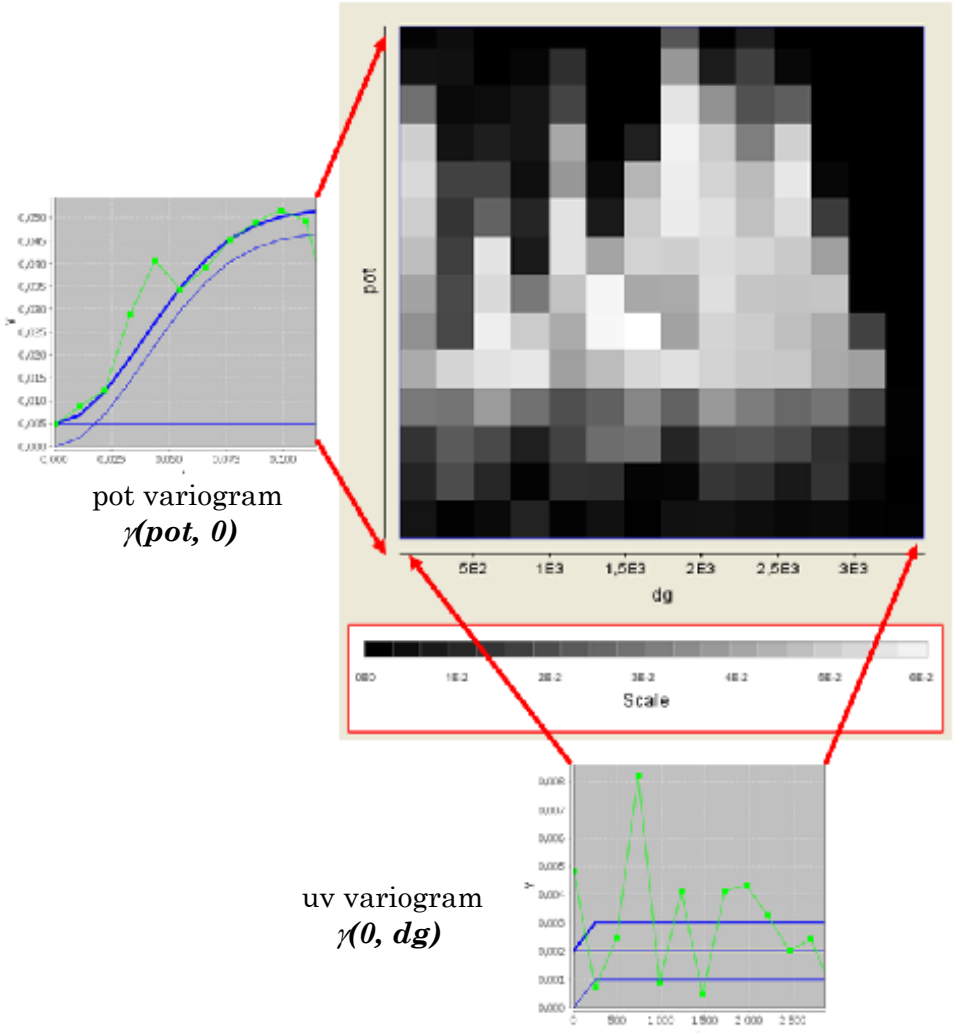

If both nugget effects are equal to zero we have:

$$\gamma(pot,dg) = C^{pot}\mathbf{Mod}(pot/r_{pot},dg/r_{dg}) + (C^{dg} - C^{pot})\mathbf{Mod}(0,dg/r_{dg}) \quad (3)$$

Giving:

$$\gamma(pot,0) = C^{pot}\mathbf{Mod}(pot/r_{pot},0) + (C^{dg} - C^{pot})\mathbf{Mod}(0,0) = C^{pot}\mathbf{Mod}(pot/r_{pot})$$

$$\gamma(0,dg) = C^{pot}\mathbf{Mod}(0,dg/r_{dg}) + (C^{dg} - C^{pot})\mathbf{Mod}(0,dg/r_{dg}) = C^{dg}\mathbf{Mod}(dg/r_{dg})$$

When the variability of the parameter to study is mainly correlated with the ***pot*** coordinate, the variogram in the space ***(pot, dg, θ)*** is in reality a function of ***pot*** and we have:

- ***γ(pot, dg, θ) = γ(pot)***

In this case, we have pure "zonal anisotropy" and the variogram is:

- ***γ(pot, dg, θ) = γ(pot) = C ^{pot}Mod(pot/ r$_{pot}$)***.

General case:

- ***γ(pot, dg, θ) = γ(pot, dg$_u$, dg$_v$)***

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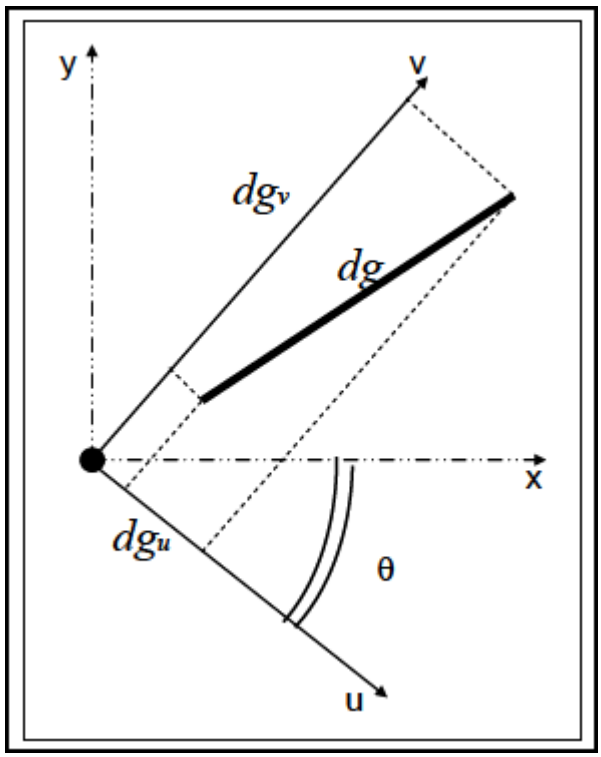
Where:

dg_u, dg_v represent respectively, the geodesic distance along the u axis and the v axis, which are the axes representing the anisotropy in the xy plane.



dg_u and dg_v are the projection on the principal axes u and v of the geodesic distance dg and u and v are the direction of anisotropy on the plane xy rotated with an angle θ from axis x and y.

If we have a geometric anisotropy on the plane xy and zonal anisotropy along the pot coordinates and two different nugget effects for the pot coordinate (C_0^{pot}) and the xy plane (C_0^{dg}), the variogram will be:

$$\begin{aligned}\gamma(pot, dg_u, dg_v) &= C_0^{pot} + (C_0^{dg} - C_0^{pot})\,\mathbf{Mod}(pot / r_{pot}, \infty, \infty) \\ &\quad + (C_0^{pot} + C^{pot} - C_0^{dg})\mathbf{Mod}(pot / r_{pot}, dg_u / r_{dgu}, dg_v / r_{dgv}) \\ &\quad + (C_0^{dg} + C^{dg} - (C_0^{pot} + C^{pot}))\mathbf{Mod}(0, dg_u / r_{dgu}, dg_v / r_{dgv})\end{aligned}$$

$$\begin{aligned}\gamma(pot, dg_u, dg_v) &= C^{pot}\mathbf{Mod}(pot / r_{pot}, dg_u / r_{dgu}, dg_v / r_{dgv}) \\ &\quad + (C^{dg} - C^{pot})\mathbf{Mod}(0, dg_u / r_{dgu}, dg_v / r_{dgv})\end{aligned} \quad (4)$$

In case where nugget effect is null we will have:

$$\begin{aligned}\gamma(pot, dg_u, dg_v) &= C^{pot}\mathbf{Mod}(pot / r_{pot}, dg_u / r_{dgu}, dg_v / r_{dgv}) \\ &\quad + (C^{dg} - C^{pot})\mathbf{Mod}(0, dg_u / r_{dgu}, dg_v / r_{dgv})\end{aligned} \quad (5)$$

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Filling physical properties using *(pot, dg, θ)* space

We use regular grids as support for the kriging. Any kind of grid or mesh could be used since kriging properties are independent of the supporting grid and refer directly to the implicit formulation of the model. Tetrahedral meshing of multi-volumes described by implicit functions with discontinuities is now a well addressed problem in the frame of De-launay triangulation (Boissonnat et al. 2008, Boltcheva et al. 2009). We propose to further use this technique in our particular case since most tools for simulation can use tetrahedrons. As an example, figure 4 illustrates a tetrahedral meshing of an implicit function, conformal with geological boundaries and following the internal isopotential. Ideally this kind of mesh should used more often.

All the tools for simulation can use tetrahedral meshing. The problem is to obtain meshes with:

- A minimum of cells,
- Conformal mesh (the frontier of two objects is shared by the adjacent cells).
- Well formed cells.

Using this technique we can:

- Control the number of cells
- Ensure that the frontier of two objects is shared by the adjacent cells,
- The size of the cell can increase inside one geological unit,

Another advantage of this technique from the user point of view is that the volume meshing is only required for the visualisation of the model. The meshing is created when we compute the representation of the geological units.

To fill the mesh we just need to know the circumcenter of the cells or the vertices of the cell and apply the geostatistical technique describe above to these points. In case of regular hexahedral grids the same procedure is applied using the centre of the cells.

When filling the properties it is also possible to fill the cells with the gradient vector of the potential field function so that we know the normal vector to the potential in each cell; this could be useful for some application like fluid flow, geophysics.

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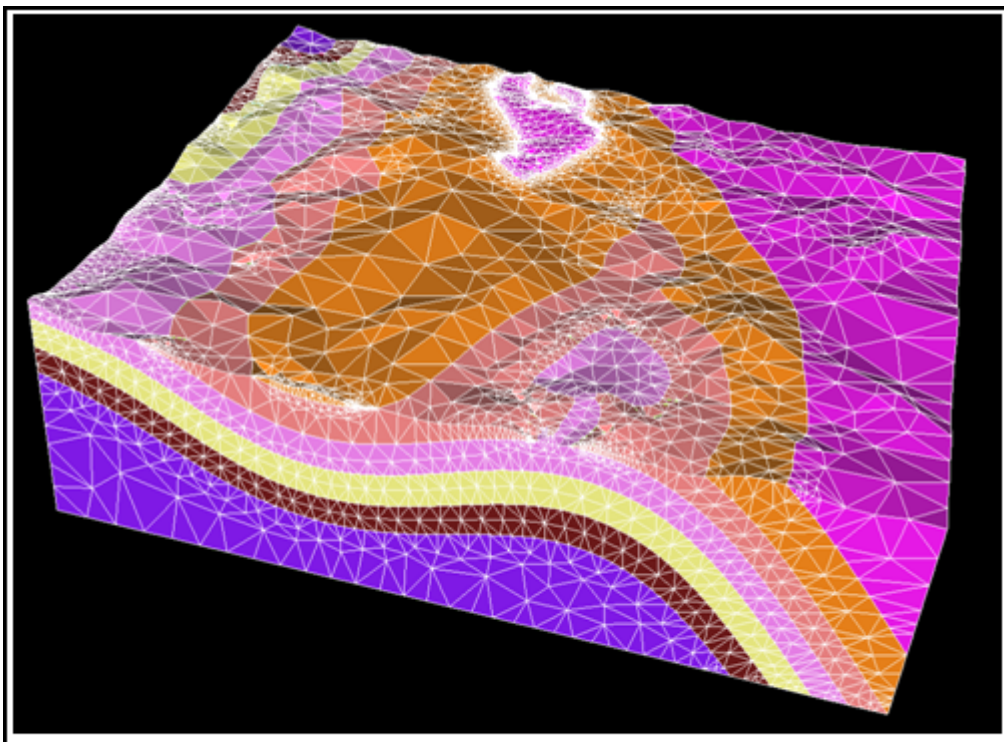

Figure 4 Tetrahedral meshing of an implicit function, conformal with geological boundaries and following the internal isopotential (performed with CGAL library).

Kriging in *(pot, dg, θ)* space

Synthetic examples:

For all the examples, a set of data representing the density of the geological units is generated:

- For each unit we define the density as a Gaussian law with a mean and standard deviation.
- Along drill holes crossing the model we generate randomly points of measurement.
- For each point of measurement, values of density are generated taking into account the geological unit and the associated statistical law to which the point belongs.
- For one unit we generate a density in function of the potential value of the geological unit.

This kind of generation of value is isotropic for the geodesic distance. The fourth constraint will generate a zonal isotropy along the pot coordinate.

Example 1:

In this example we generate data using the fourth constraints, for a geological unit. So the variogram will be isotropic for the geodesic coordinate.

The probability density function (pdf) $f_1(p,d)$, used to randomly generate the density at a point p in this unit is a Gaussian one;

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$$f_1(p,d) = \frac{e^{-\frac{1}{2}\left(\frac{d-m_1}{\sigma_1}\right)^2}}{\sqrt{2\Pi}\sigma_1}$$

Where m_1 represents the mean and σ_1 the standard deviation.

Here m_1 = 2.78 and σ_1 = 0.03

When the point p in a borehole has a potential field ***pf(p)*** , with

pf1 < pf(p) < pf2 we use another Gaussian pdf,

$$f_{anom}(p,d) == \frac{e^{-\frac{1}{2}\left(\frac{d-m_2}{\sigma_2}\right)^2}}{\sqrt{2\Pi}\sigma_2}$$

with m_2 = 2.91 and σ_2 = 0.05. The values pf1 and pf2 are chosen to obtain the density peak close to the bottom of the unit.

We placed another constraint on $f_{anom}(p,d)$. We imposed that the high densities are aligned along a NE-SW direction, and decrease when distance increases from a given plane P(x,y,z) with a smoothing function,

$$sf(dist) = e^{-3\left(\frac{dist}{a}\right)^2}$$

where dist is the distance between the point p and the plane P(x, y, z) .
In summary ***f(p,d)*** the pdf describing the probability to find a density d at a point p that belongs in the unit is:

$$\begin{array}{ll} \text{If} \quad pf1 < pf(p) < pf2 & f(p,d) = sf(dist) * f_{anom}(p,d) + (1 - sf(dist)) * f_1(p,d) \\ \text{else} & f(p,d) = f_1(p,d) = \dfrac{e^{-\frac{1}{2}\left(\frac{d-m_1}{\sigma_1}\right)^2}}{\sqrt{2\Pi}\sigma_1} \end{array}$$

In this example we define a vertical plan P oriented SW-NE. The data are generated along boreholes applying the previous rules. The figure below shows the result of interpolation using kriging:

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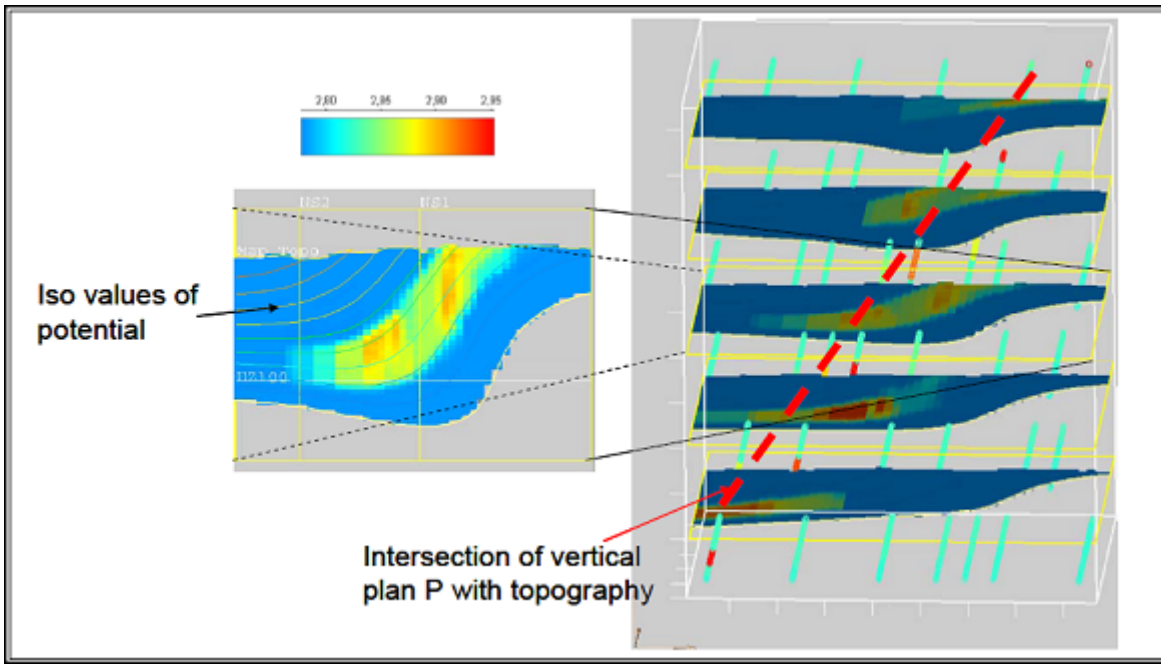
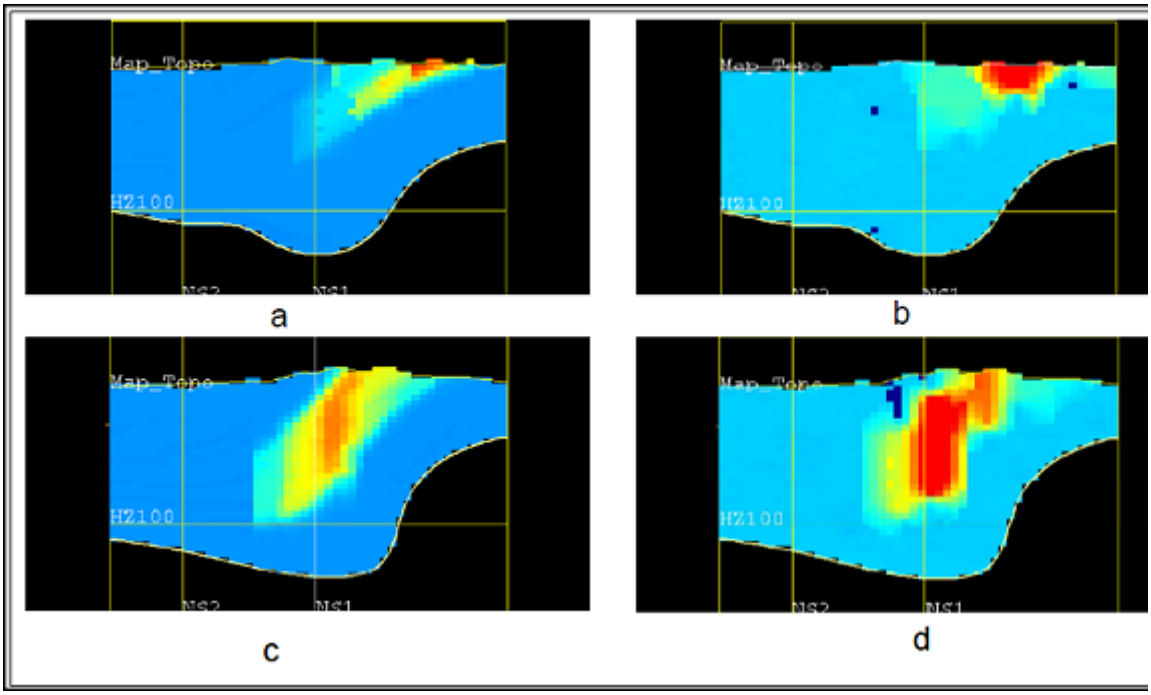


The next figure shows the difference between kriging that takes into account geometry on the left (a,c) and classical kriging using only the Euclidian distance on the right (b,d).



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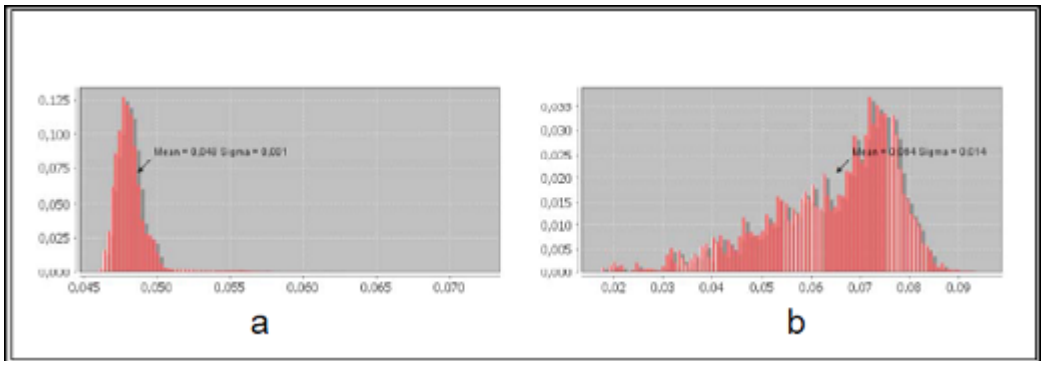
As the original data where generated takes into account the geological structure, the next figure shows the difference in the variance of estimation. The variance is much smaller when geometry is taken into account (a), than when using classical kriging (b).



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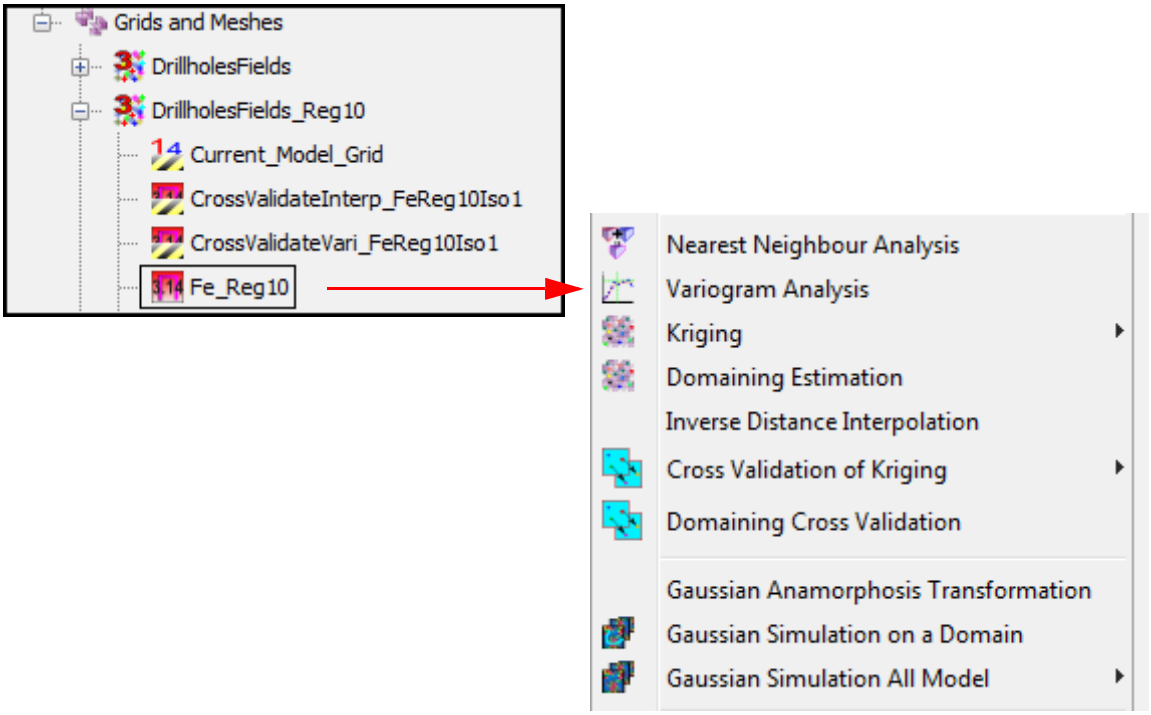
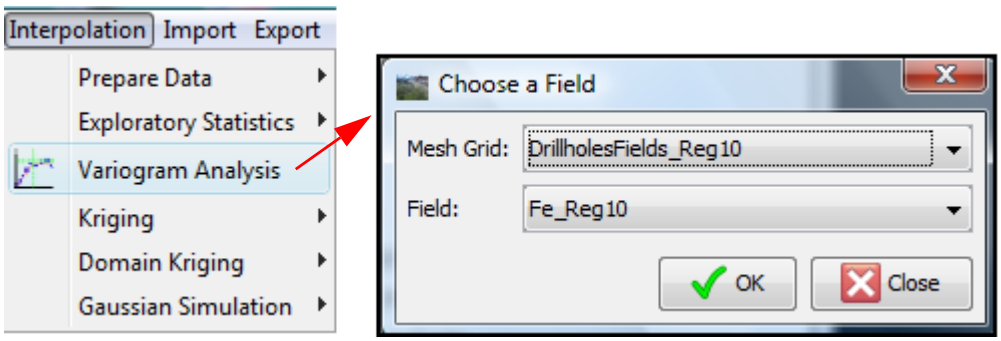
- **Domain Kriging Variogram Analysis - Worked Example**
  - Select a variable for variogram analysis from the Grids and Meshes context menu OR



  - Choose Variogram from Interpolation drop down in the Main menu.



  - **Step 1 - New Variogram Analysis**
    - Choose a new variogram analysis or modify an existing variogram model
    - Choose from the two Domain variogram types
      - Potential - thickness (t); quick to calculate. The distance between two points perpendicular to the potential ie the absolute value of the difference between ***pot(A)*** and ***pot(B),*** ref ***pot distance*****: P251**
      - (uv, potential) - u,v and thickness; slow to calculate. Incorporates the distance and direction along the potential as well as the thickness - two separate variograms, ref TBD.
    - Choose the **Maximum Radius** for the neighbourhood search

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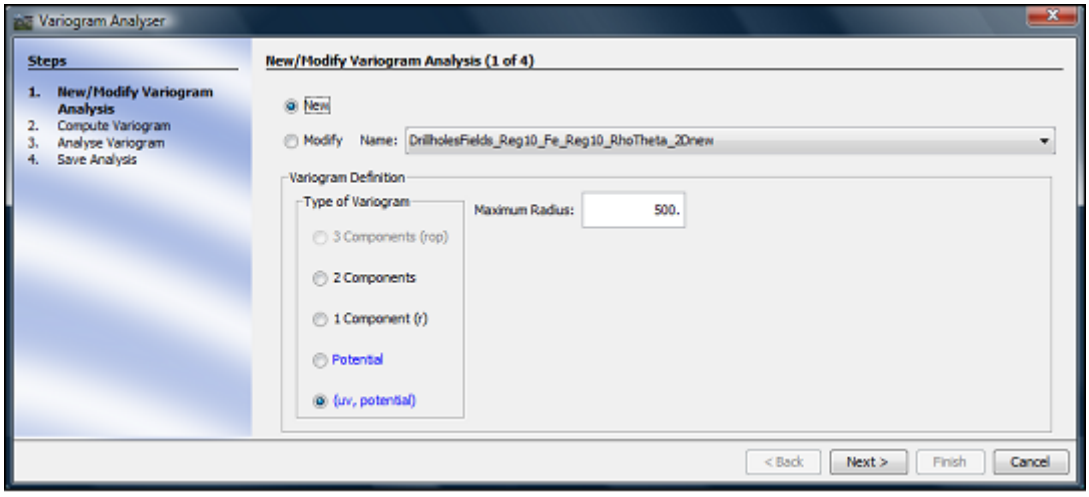
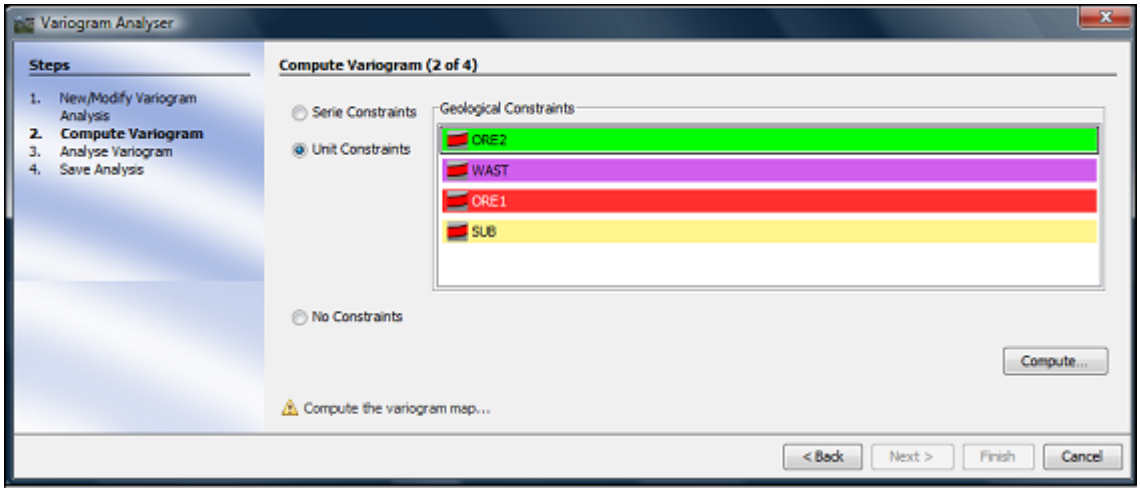


- **Step 2 - Compute Variogram**
  - Select Series or Unit Constraints
    - Select one Series or Unit (Formation) from the list - ORE2
  - Alternatively toggle No Constraints
  - When done click on Compute to calculate the variogram map. ***This is a very cpu intensive process and takes a long time to compute depending on the search radius and the number of observation points in the model. The distances between the points must be computed in the uv,potential coordinate space.*** A progress bar provides feedback to the user.
  - The alternative Domain kriging option of **Potential** is much faster and can give good results depending on the model complexity (degree of anisotropy).



- **Step 3 - Analyse Variogram**
  - Adjust the number of Lags for the uv and t directions to locate the optimum point distributions for the variogram fitting step; examine the grey scale image

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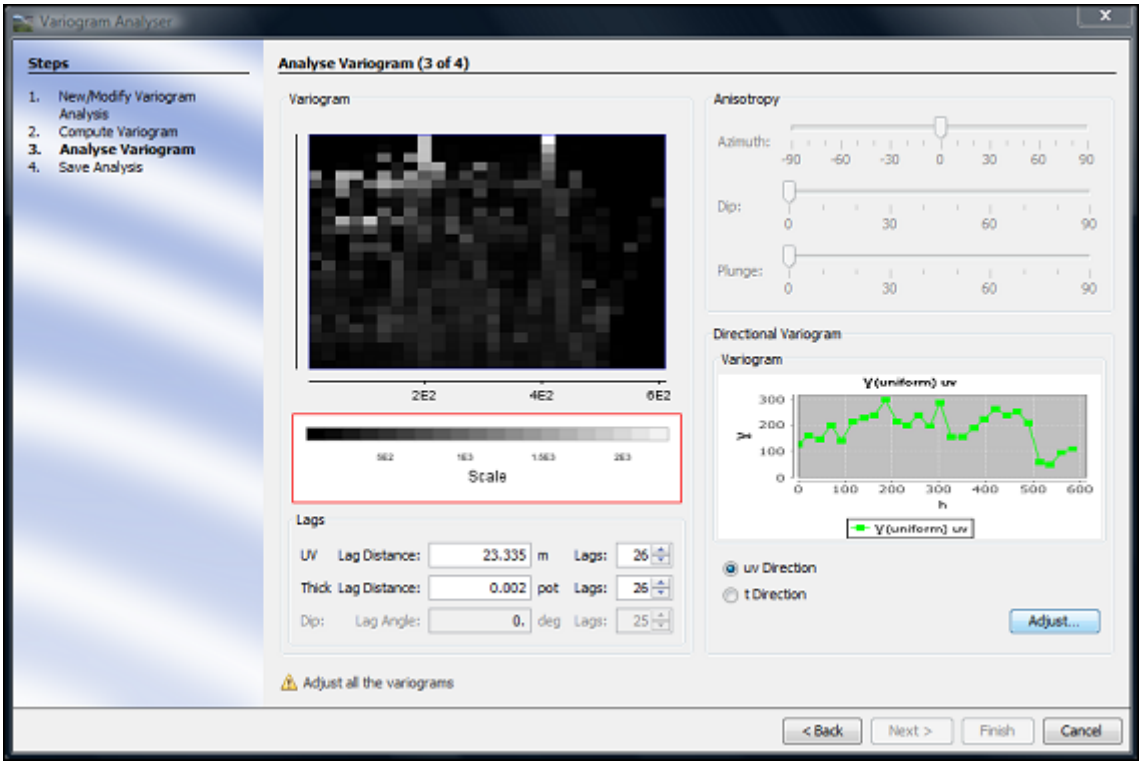
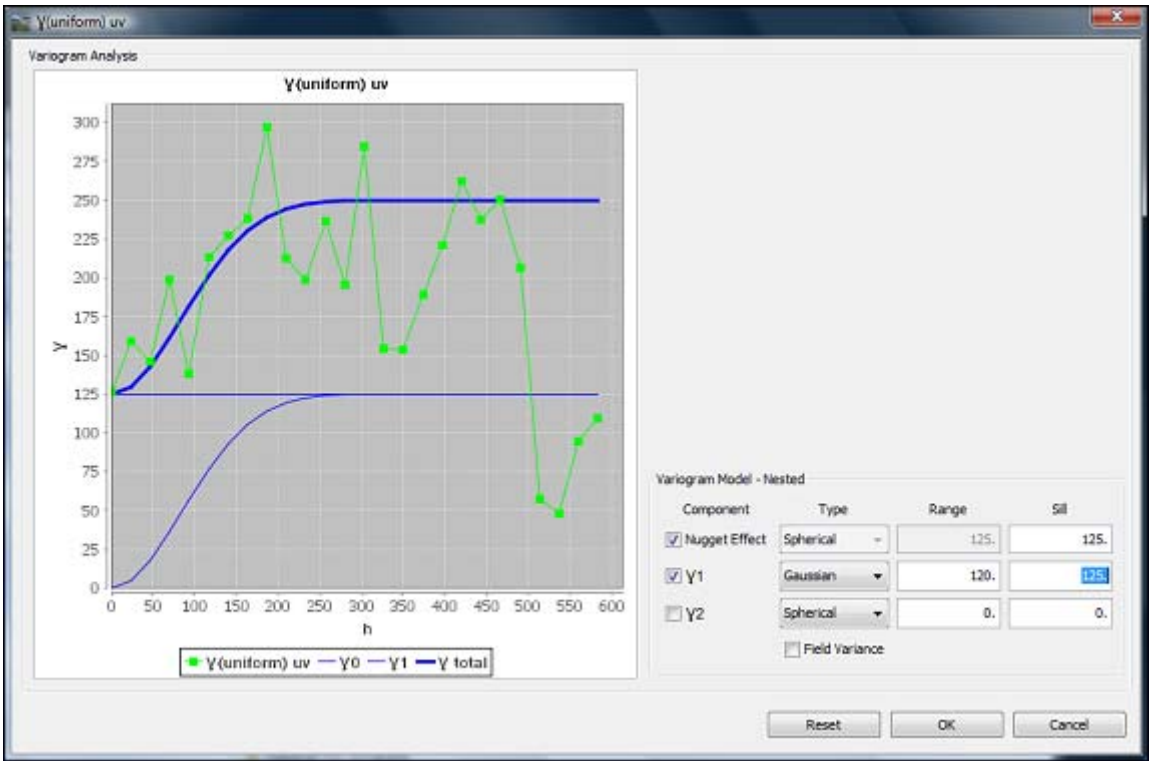


- Click **Adjust** to open the uv fit dialog and step through the fitting process
  - Toggle **Nugget Effect** and enter the nugget **Sill** value; hit <Return>
  - Toggle γ1, model **Type** and enter the **Range** and **Sill** to obtain a reasonable fit to the data points
  - Toggle γ2 and fit a second nested model with **Range** and **Sill** to obtain a better fit to the data. The nested models are additive.



- Click OK to accept the fitted uv model and return to the previous dialog.

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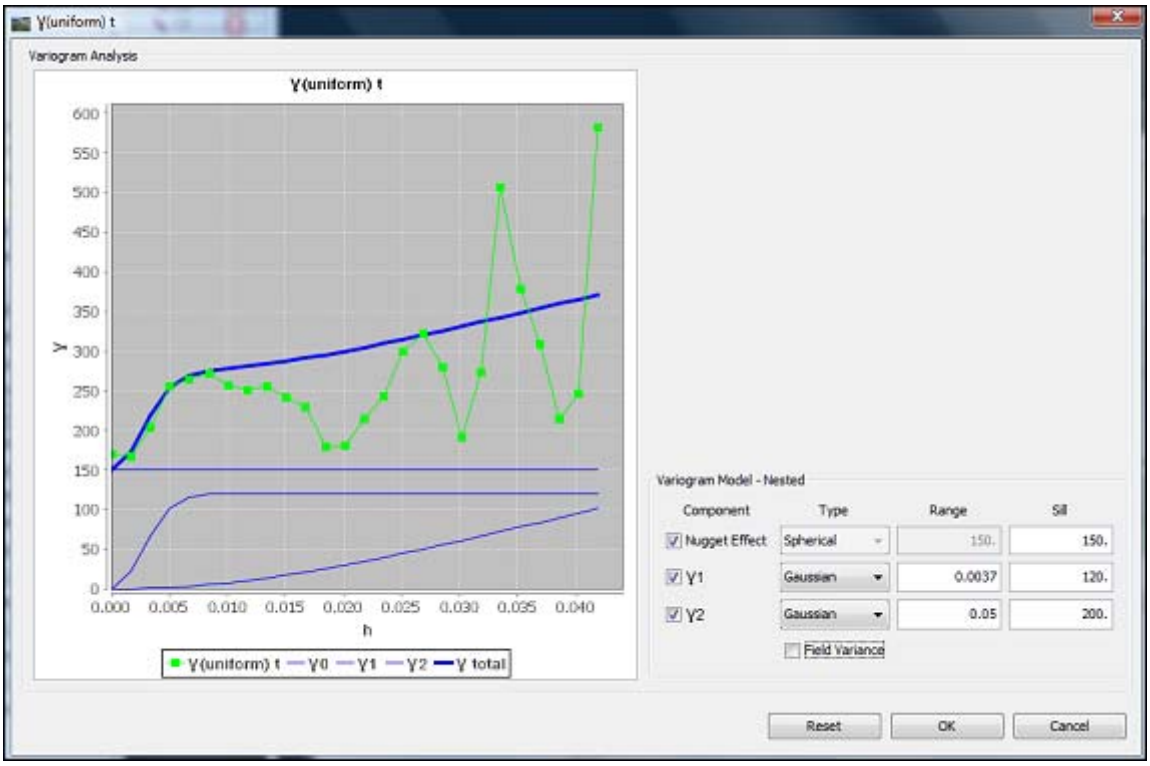
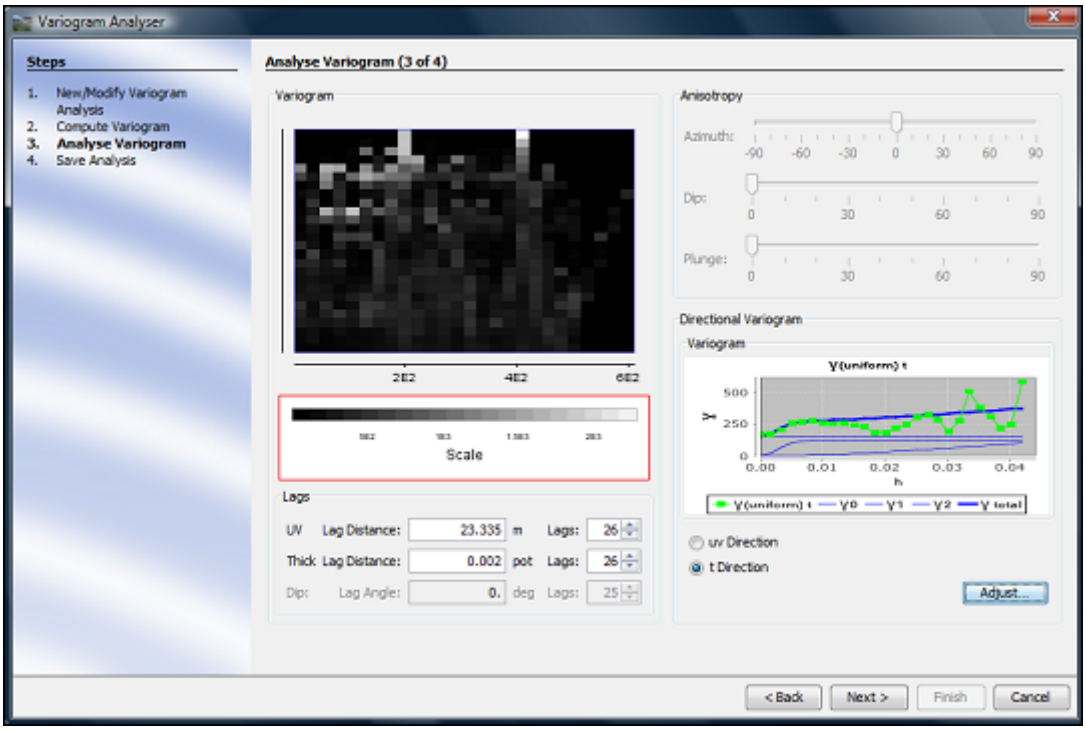
- Toggle **t Direction** and click **Adjust** to open the t fit dialog and step through the fitting process as for uv fitting above.



- Click OK to accept the fitted t model and return to the **Step 3** dialog.



- Click Next to proceed to Step 4 to save the variogram analysis.

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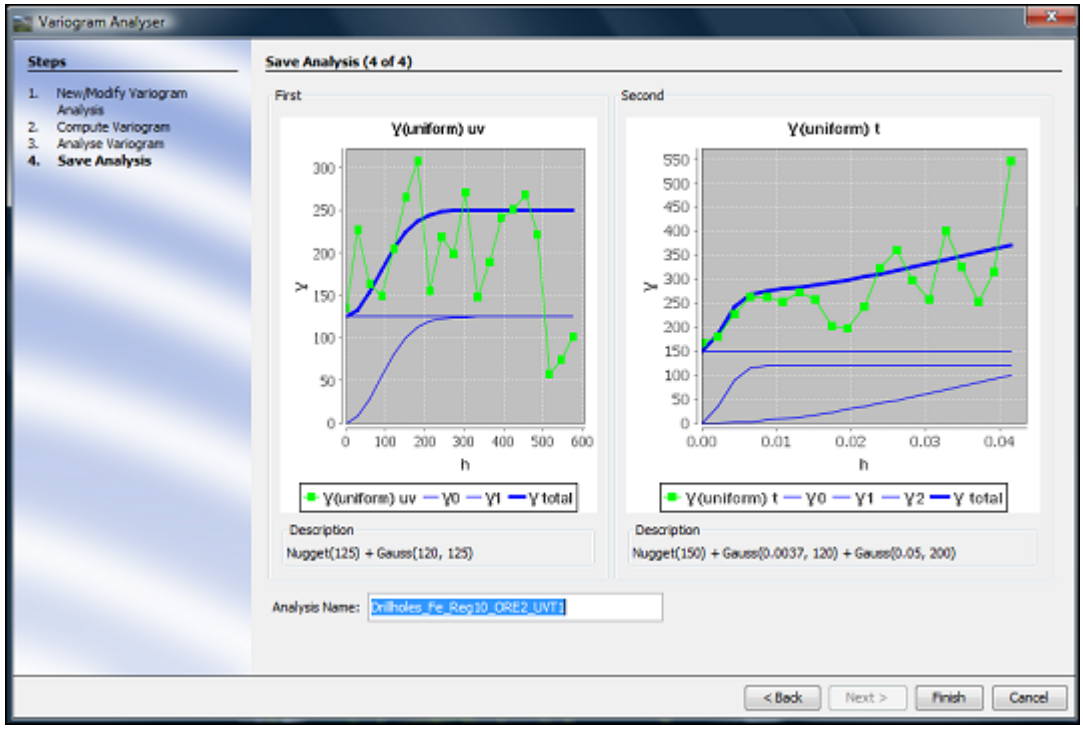
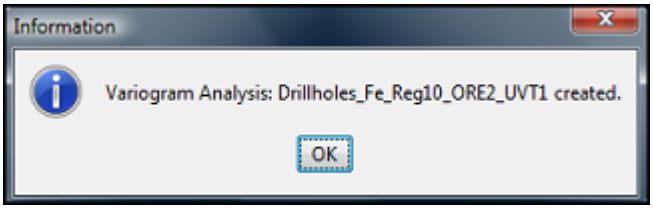
- **Step 4 - Save Analysis**
  - The Step 4 dialog shows a graphic summary of the variograms fitted for *uv* and *t* and displays the variogram model equations under **Description** in the lower panel below each graph.
  - Enter or edit the default **Analysis Name** and click **Finish** to save the results.



  - The user is advised that the variogram analysis has been created



  - The Project must be saved to complete the process as the variogram analysis is saved in the Project xml.

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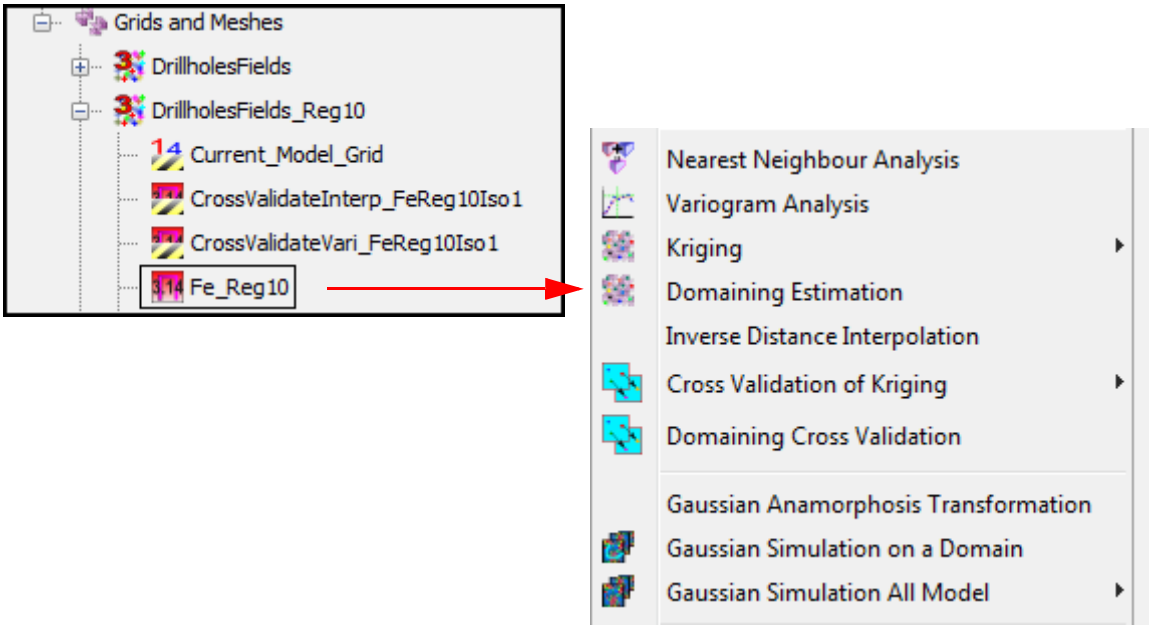
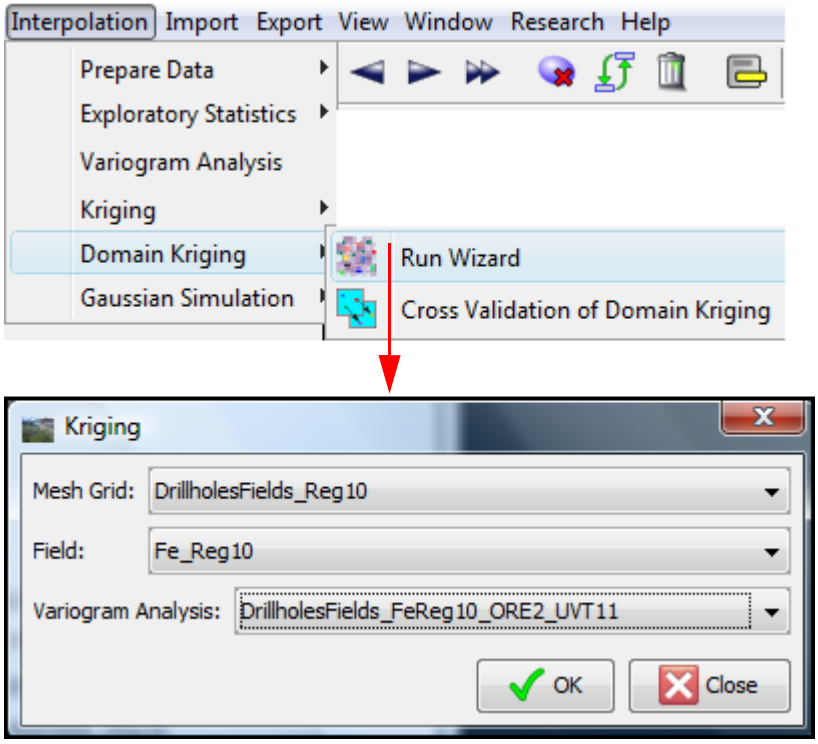
- **Domain Kriging Interpolation - Worked Example**
  - Select a variable for domain kriging from the Grids and Meshes context menu OR



  - Select **Domain Kriging** then **Run Wizard** from the **Interpolation** drop down in the **Main** menu



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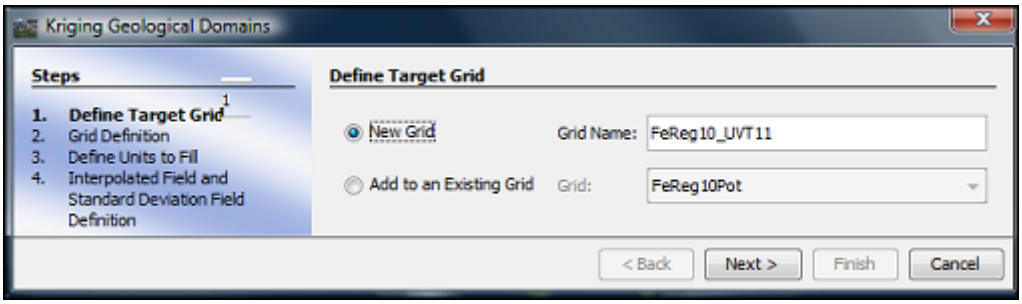
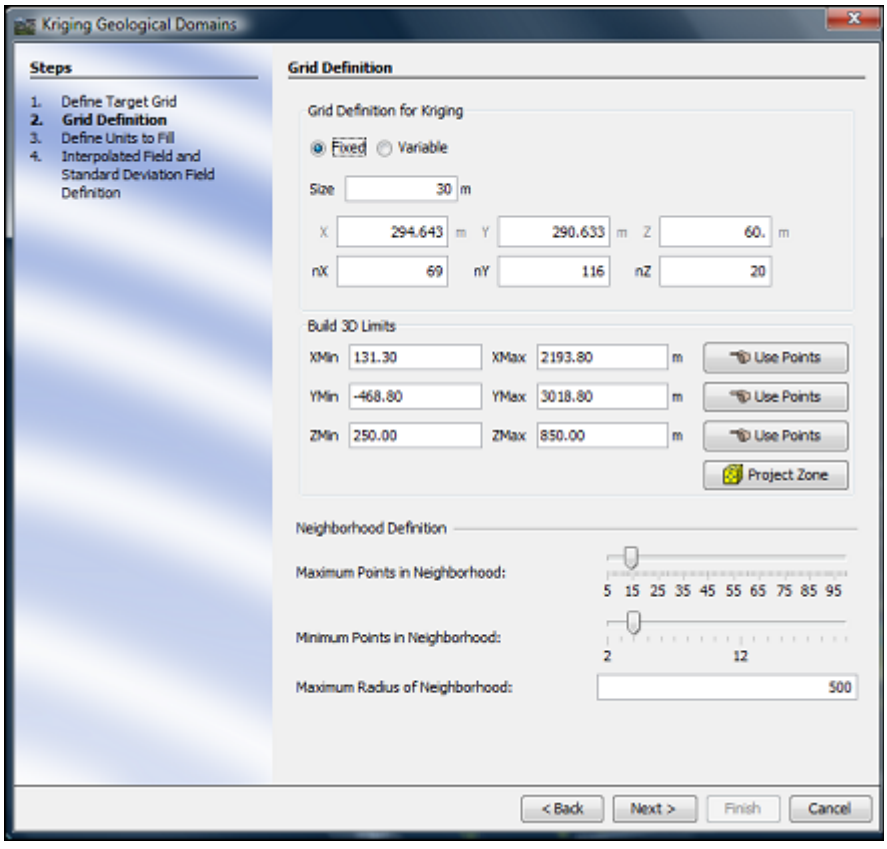
- **Step 1. Define Target Grid**
  - Choose **New Grid** -and type a new grid name or
  - Choose **Add to an Existing Grid** and select from the list of existing grids with the desired characteristics ie cell/voxet size and extents. The Kriging result will be written to the existing grid in a new field.
  - Click **Next >** to continue



- **Step 2. Grid Definition** - Define the output grid resolution and extents and neighbourhood search parameters
  - **Grid Definition for Kriging** - Define output grid fixed or variable cell sizes or the number of grid cells in the X ,Y & Z directions in the top panel.
  - **Build 3D Limits** - Interpolate a subset of the 3D GeoModeller project by entering new X, Y, Z min/max limits or accept the default of the full project area. The project extents can be reset by clicking on the **Project Zone** button.
    - **Use Points** - You can use points digitised on a section in the 2D Viewer or captured in the Points list editor to set the X, Y, Z min/max limits by clicking on the **Use Points** buttons.


Kriging Geological Domains
Steps
1. Define Target Grid
2. Grid Definition
3. Define Units to Fill
4. Interpolated Field and Standard Deviation Field Definition
Grid Definition
Grid Definition for Kriging
Fixed
Variable
Size 30 m
X 294.643 m Y 290.633 m Z 60. m
nX 69 nY 116 nZ 20
Build 3D Limits
XMin 131.30 XMax 2193.80 m Use Points
YMin -468.80 YMax 3018.80 m Use Points
ZMin 250.00 ZMax 850.00 m Use Points
Project Zone
Neighborhood Definition
Maximum Points in Neighborhood:
5 15 25 35 45 55 65 75 85 95
Minimum Points in Neighborhood:
2 12
Maximum Radius of Neighborhood: 500
< Back
Next >
Finish
Cancel

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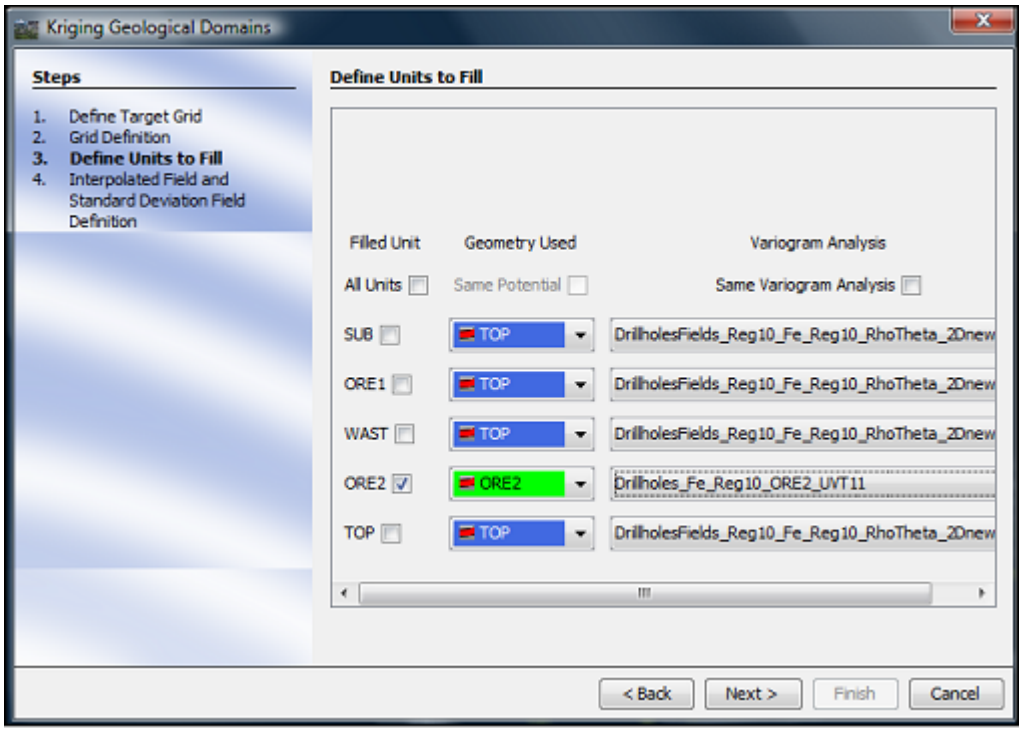
- **Neighbourhood Definition** options are:
  - **Maximum Points in neighbourhood**: The algorithm does a radial search for points from the centre of the cell to be interpolated. It stops searching once the Maximum Points limit is reached. Limiting the Maximum Points in the neighbourhood minimises smoothing if the local data mean is known to fluctuate considerably and also speeds up matrix inversion.
  - **Minimum Points in neighbourhood**: The minimum number of points in the radial search required to calculate a value for the cell. If the minimum is not reached then the cell value is set to Null.
  - **Maximum Radius of Neighbourhood:** The maximum radial search distance used to scan for points to include in the estimation of a cell value.
  - Click **Next >** to continue to **Step 3**
- In setting the **Neighbourhood Definition** search options the user should consider the range of the variogram being used and the minimum/ maximum separation of observation points in the kriging neighbourhood. It is not good practice to limit the search radius to the largest variogram range. Although a location u_α may be beyond the range ie if $Cov(u - u_\alpha) = 0$, the data value $z(u_\alpha)$ still provides information about the unknown mean value m(u) at the location u being estimated, cref GSLIB Application Notes IV.6 p105.
- The **Nearest Neighbour analysis** tool is useful in providing statistics of the spacing of observations and can help in setting the optimum Neighbourhood definition parameters.

- **Step 3. Define Units to Fill**



- Toggle the **Filled Unit** (Formation) to interpolate
- Select a Unit from the **Geometry Used** drop down

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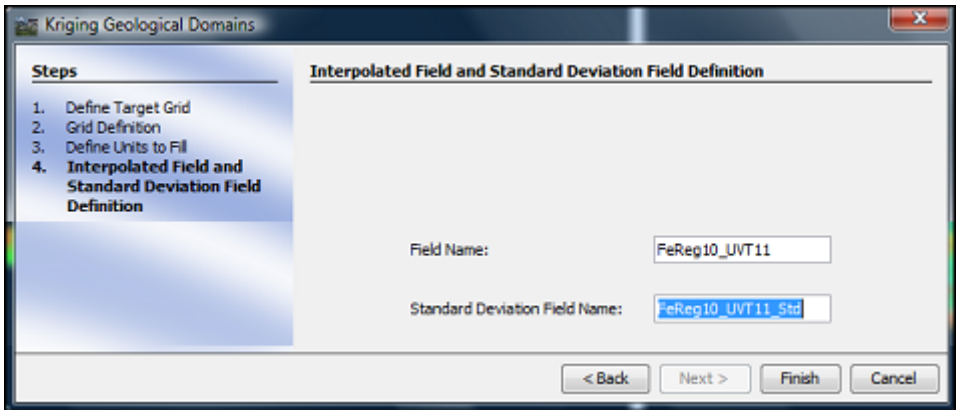
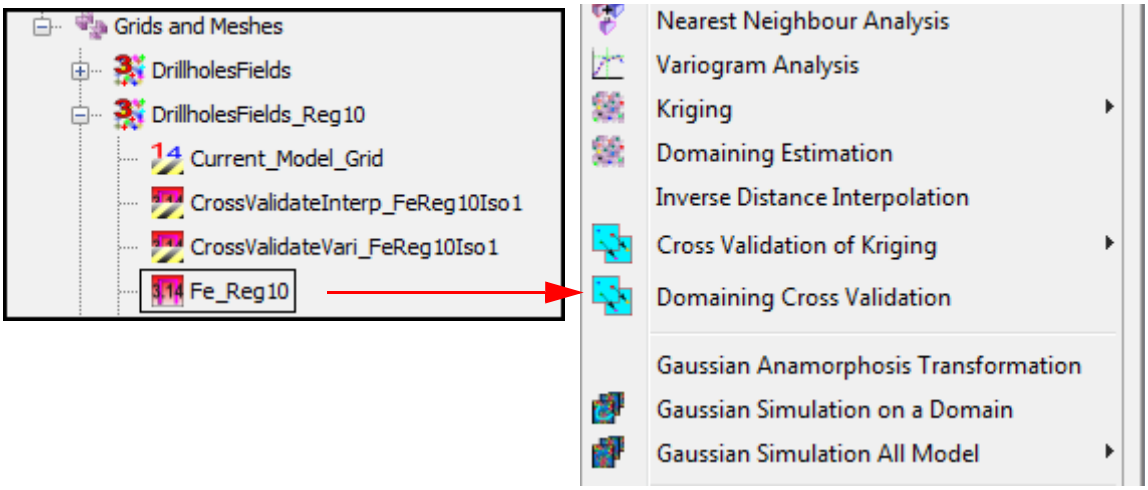
- Select the **Variogram Analysis to use** from the drop down lists
- Normally you would select the **Unit** that was modelled in the **Variogram Analysis** for the **Filled Unit** and **Geometry Used**
- There are Toggles available to select **All Units** and/or to use the **Same Variogram Analysis** for all the selected **Units** (Formations)
- Click **Next >** to continue to **Step 4**

- **Step 4. Interpolated Field and Standard Deviation Field Definition**
  - Enter interpolation output names in the **Field Name** and **Standard Deviation Field Name** data boxes
  - Click **Finish** button to run the interpolation
  - The 3D output grid will be available for visualisation in the Grids and Meshes section of the **Explore** tree.



- The usual Visualisation options are available in 2D and 3D.
- **Domaining Cross Validation**
  - Select a variable for domain kriging from the Grids and Meshes context menu OR



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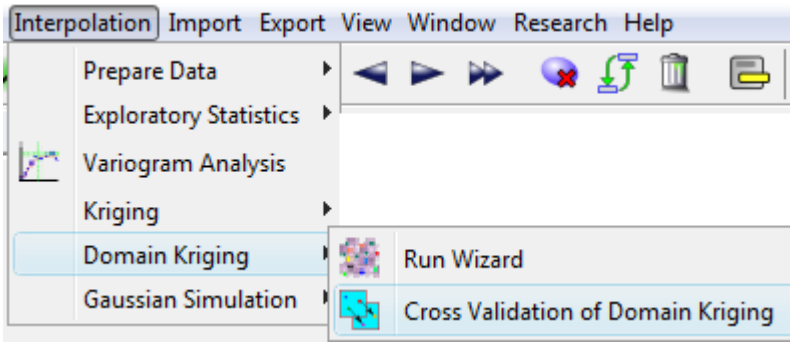
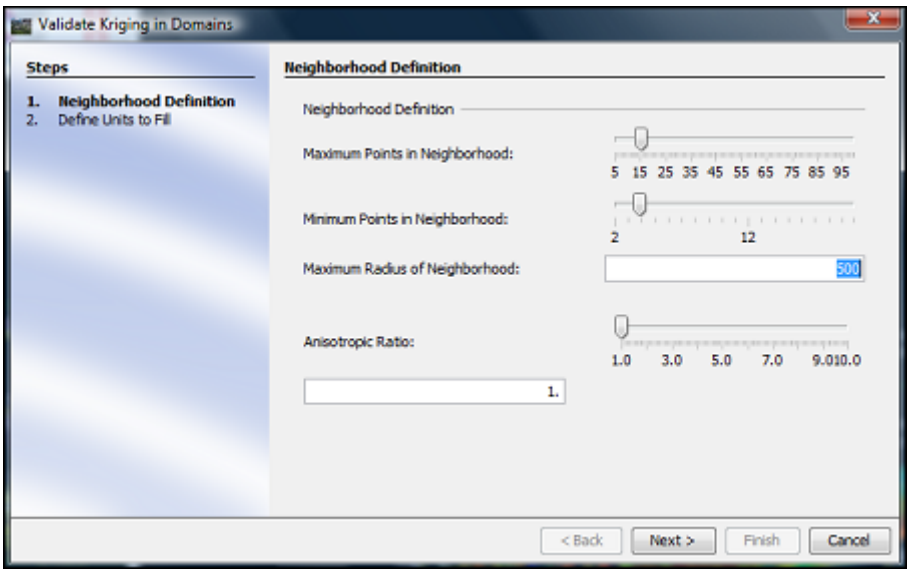
- Select **Domain Kriging** then **Cross Validation of Domain Kriging** from the **Interpolation** drop down in the **Main** menu



- **Step 1. Neighbourhood Definition**
  - Define the Neighbourhood parameters with which to run Cross Validation. These parameters would normally match those used in the Variogram Analysis and subsequent Domain Kriging interpolation



  - **Maximum Points in neighbourhood**: The algorithm does a radial search for points from the centre of the cell to be interpolated. It stops searching once the Maximum Points limit is reached. Limiting the Maximum Points in the neighbourhood minimises smoothing if the local data mean is known to fluctuate considerably and also speeds up matrix inversion.
  - **Minimum Points in neighbourhood**: The minimum number of points in the radial search required to calculate a value for the cell. If the minimum is not reached then the cell value is set to Null.
  - **Maximum Radius of Neighbourhood:** The maximum radial search distance used to scan for points to include in the estimation of a cell value.
  - **Anisotropic Ratio:** This parameter is not currently relevant to this procedure and should be left as the default of 1.
  - Click **Next >** to continue to **Step 2**

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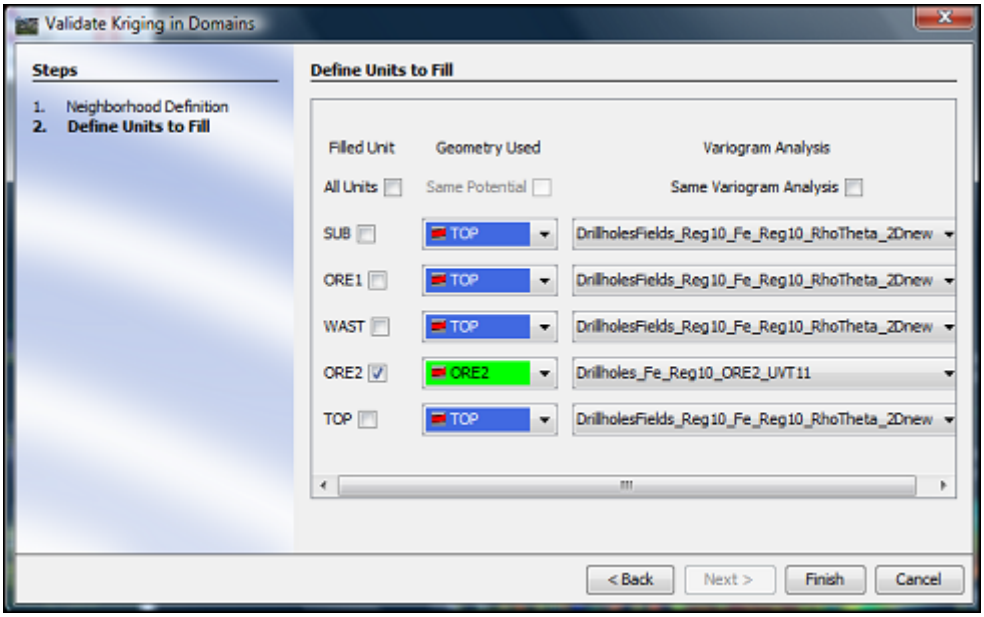
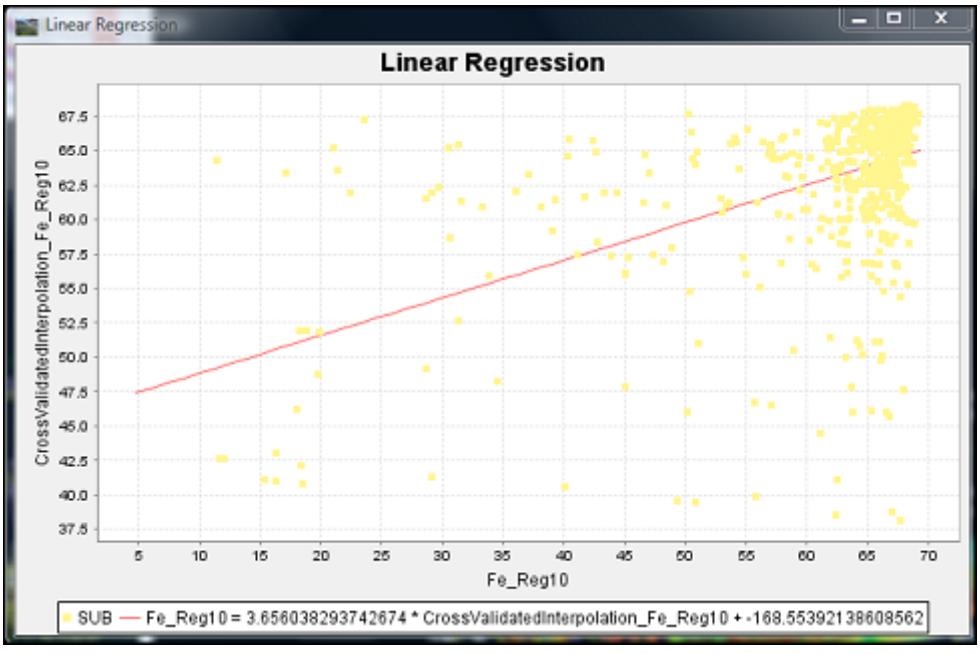
- **Step 2. Define Units to Fill**
  - Select the Units in the same manner as described for the Domaining Estimation procedure.



  - Toggle the **Filled Unit** (Formation) to interpolate
  - Select a Unit from the **Geometry Used** drop down
  - Select the **Variogram Analysis to use** from the drop down lists
  - Normally you would select the **Unit** that was modelled in the **Variogram Analysis** for the **Filled Unit** and **Geometry Used**
  - There are Toggles available to select **All Units** and/or to use the **Same Variogram Analysis** for all the selected **Units** (Formations)
  - Click **Finish** to run Domain Cross Validation
- The Domain Cross Validation graph is displayed together with a linear regression fit of Observed Fe_Reg10 versus Interpolated Fe_Reg10.



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- This result indicates a poor fit of interpolated to observed and is a reflection of the poor quality variogram analysis model which did not fit the data very well.

Sequential Gaussian Simulation (SGS)

Stochastic simulation is a means for generating multiple equiprobable realizations of the property in question, rather than simply estimating the mean. Essentially, we are adding back in some noise to undo the smoothing effect of kriging. This possibly gives a better representation of the natural variability of the property in question and gives us a means for quantifying our uncertainty regarding what's really down there.

The two most commonly used forms of simulation for reservoir modeling applications are sequential Gaussian simulation for continuous variables like porosity and sequential indicator simulation for categorical variables like facies.

The basic idea of sequential Gaussian simulation (SGS) is very simple. Recall that kriging gives us an estimate of both the mean and standard deviation of the variable at each grid node, meaning we can represent the variable at each grid node as a random variable following a normal (Gaussian) distribution. Rather than choose the mean as the estimate at each node, SGS chooses a random deviate from this normal distribution, selected according to a uniform random number representing the probability level.

The basic steps in SGS algorithm are listed below (Deustch, C. V., Journel, 1992):

- Calculate a histogram and summary statistics of the raw data.
- Transform data into Gaussian space (Gaussian Anamorphosis).
- Calculate variogram model of Gaussian transformed data.
- Define a grid to contain the simulation results
- Generate a random path through the grid nodes
- Visit the first node along the path and use kriging to estimate a mean and standard deviation for the variable at that node based on surrounding data values.
- Select a value at random from the corresponding normal distribution and set the variable value at that node to that number
- Visit each successive node in the random path and repeat the process, including previously simulated nodes as data values in the kriging process
- Back transform the simulated values (reverse the anamorphosis transformation)

We use a random path (Equation 1) to avoid artifacts induced by walking through the grid in a regular fashion. We include previously simulated grid nodes as "data" in order to preserve the proper covariance structure between the simulated values.

$$R_i = mod(5R_{i-1} + 1.2^m) = (5R_{i-1}) + 1 - int\left\{\frac{5R_{i-1}+1}{2^m}\right\}2^m \qquad (1)$$

Where: R_i is a random indicator for node i, m is a large number which makes (2^m) greater than the number of network's nodes. (Gomez -Hernandez and Srivastava, Brately 1983)

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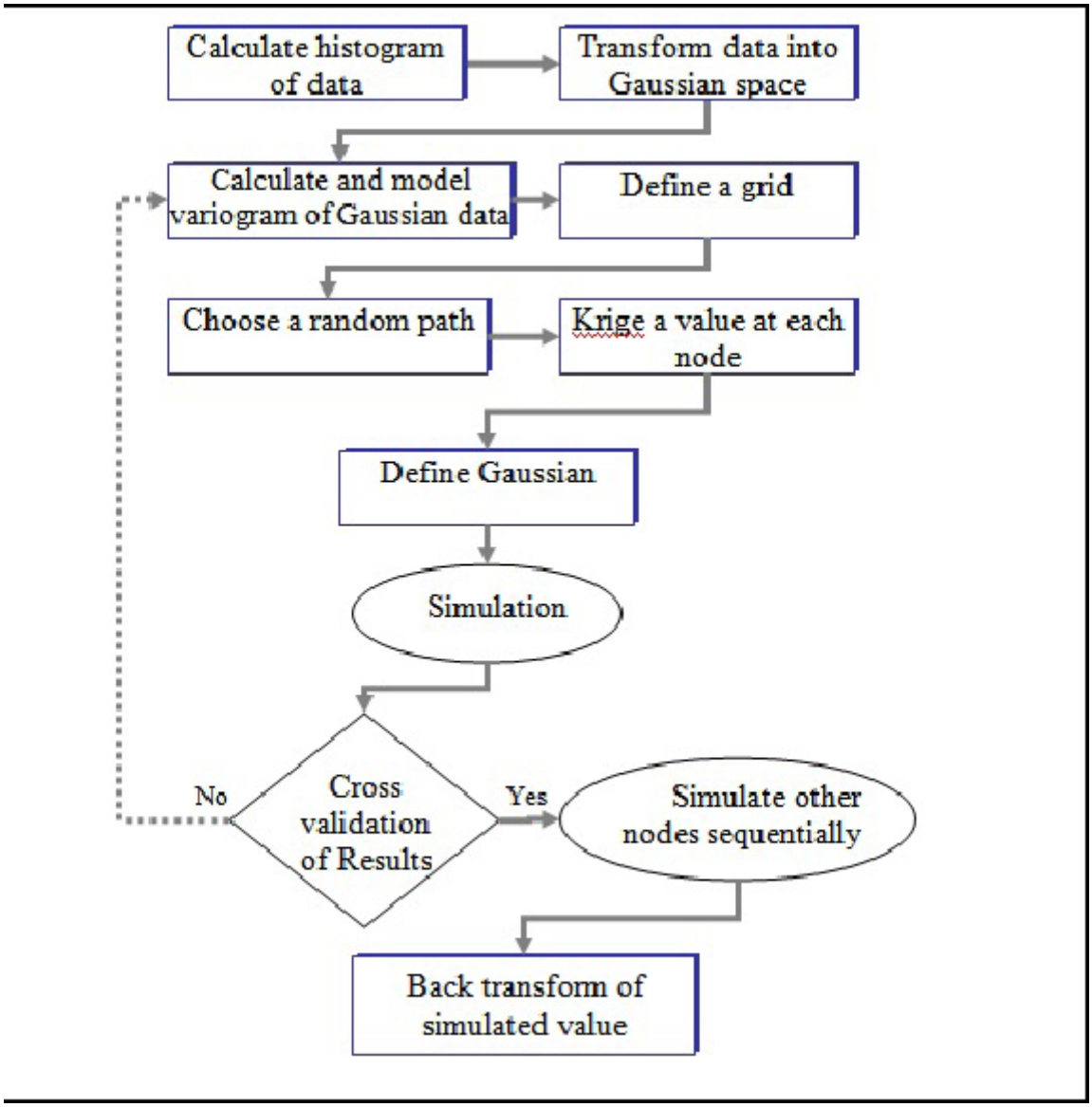

Fig. 1: The basic steps in SGS algorithm (Deustch, C.V., Journel, 1992).

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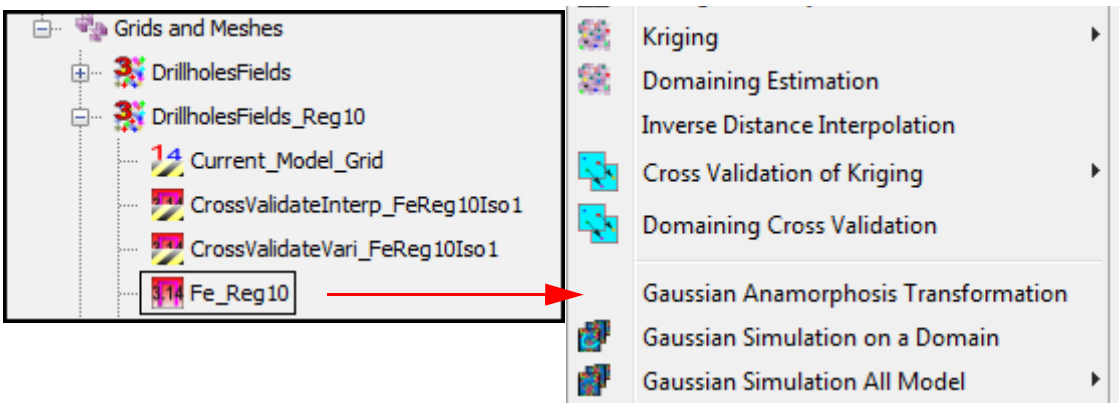
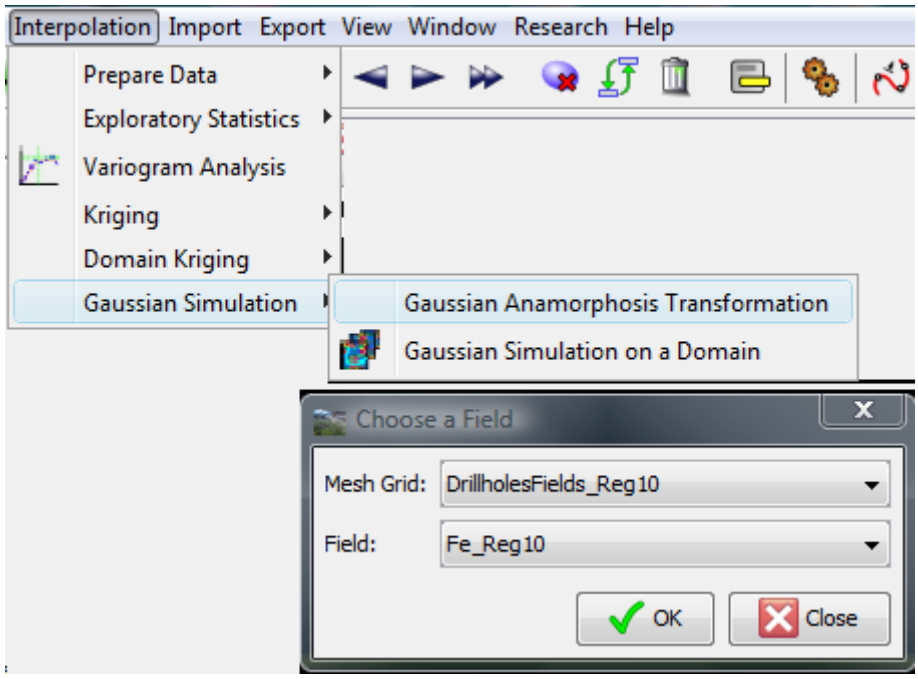
- **Gaussian Simulation**
  - **Step 1. Histogram and Statistical Analysis of the Observed Field**
  - **Step 2. Gaussian Anamorphosis Transformation**
    - Select the variable to be simulated and perform a Gaussian Anamorphosis transformation from the Grids and Meshes context menu.
    - A new field is computed and added to the source grid, **GaussianAnamorphosis_Fe_Reg10**



OR

- Select **Gaussian Simulation** then **Gaussian Anamorphosis Transformation** from the **Interpolation** drop down in the **Main** menu
- Choose the **Mesh Grid** and **Field** to be transformed.
- Click OK



- A new field is computed and added to the source grid, **GaussianAnamorphosis_Fe_Reg10**

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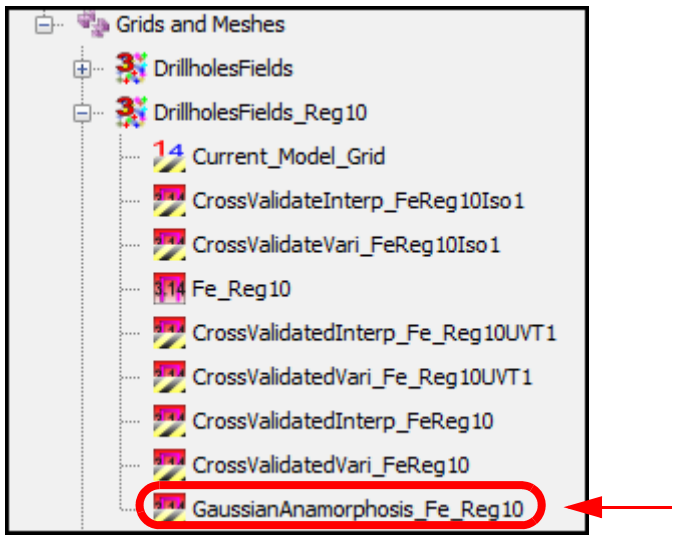
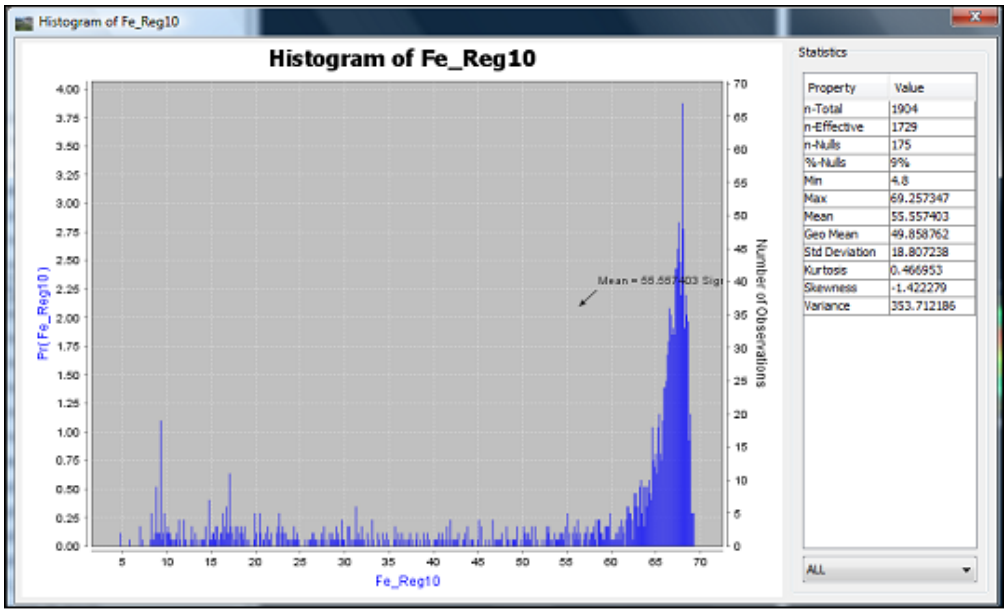
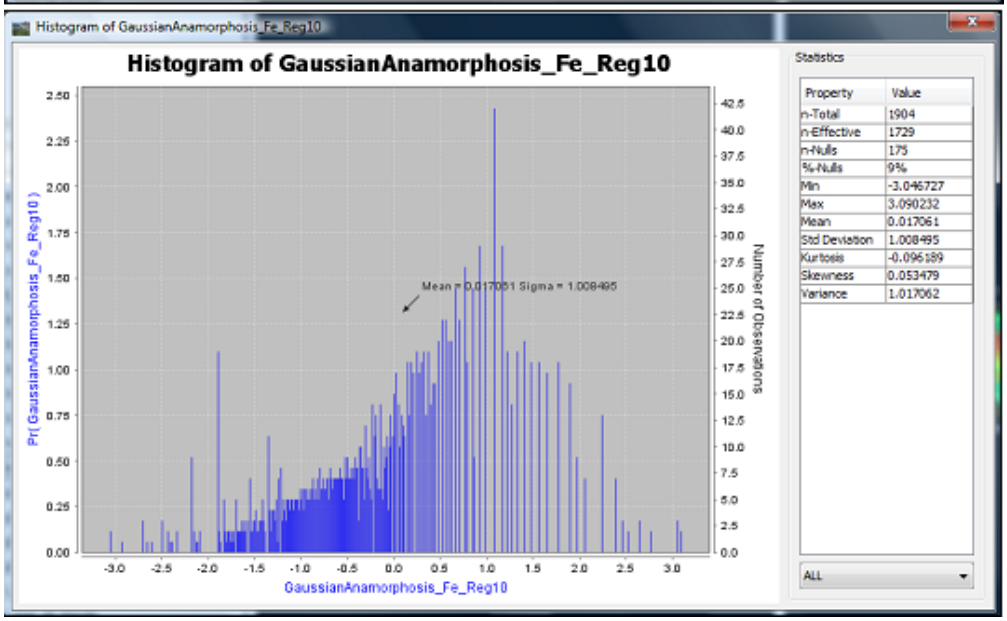


- Check the statistics of the pre and post transformed data to verify a suitable normal (gaussian) distribution





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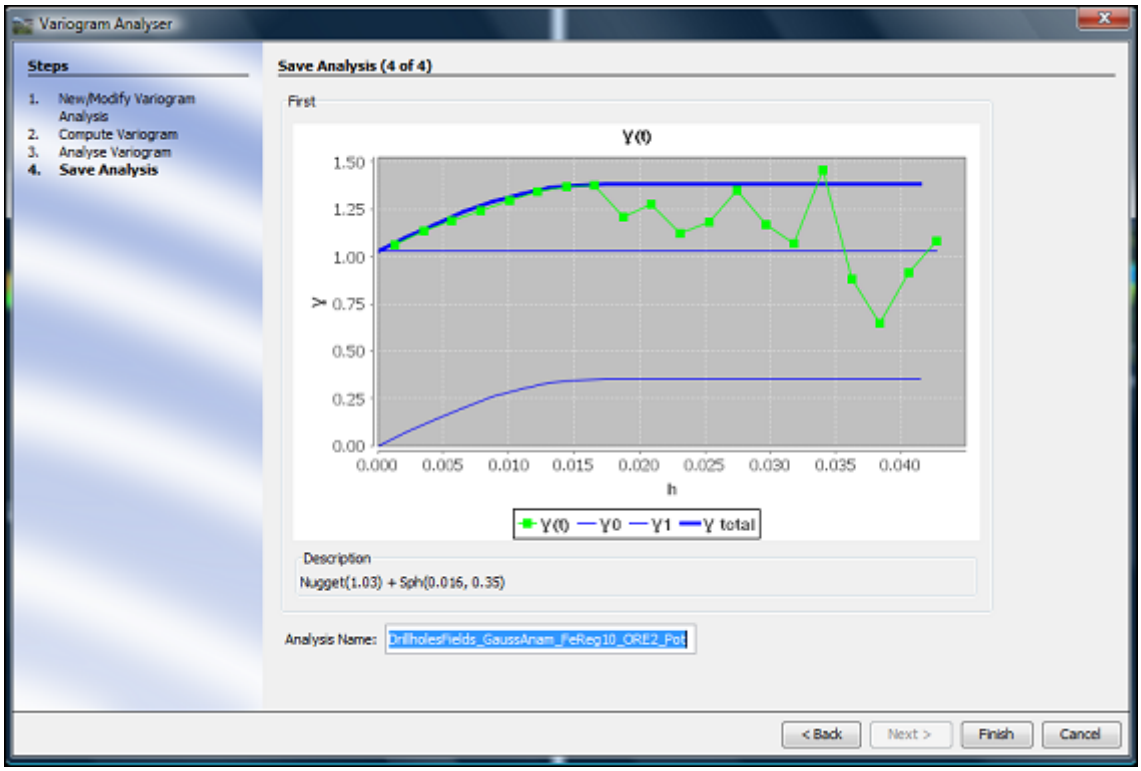
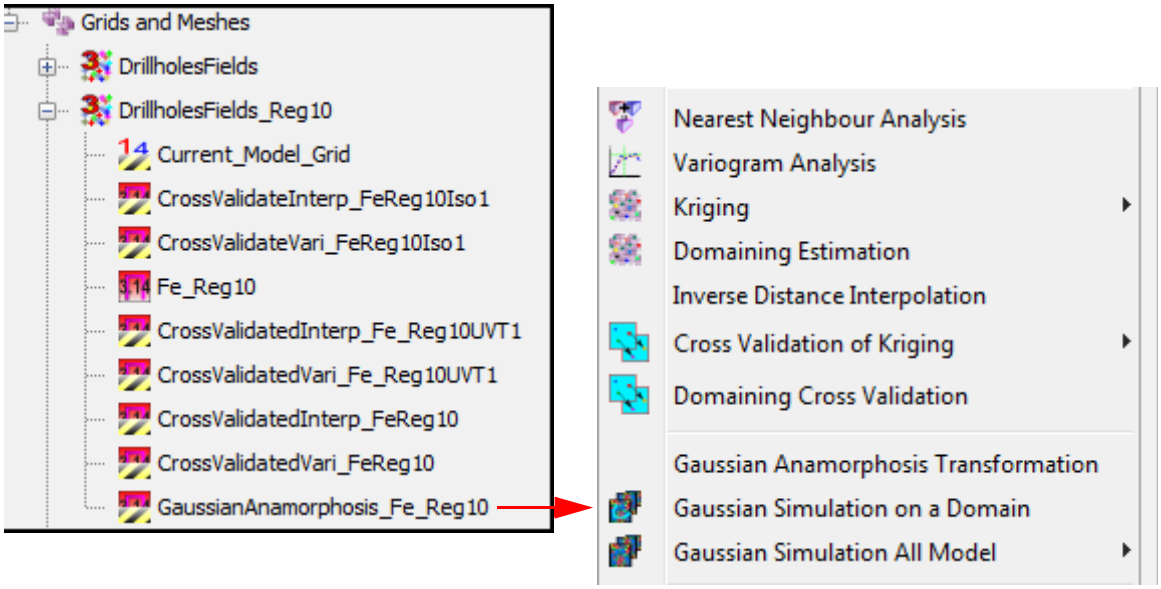
- **Step 3. Variogram Analysis of the transformed variable**
  - Calculated variogram model using Pot on Unit (Formation) ORE2



- **Step 4. Gaussian Simulation on a Domain**
  - From the Grids and Meshes Context Menu



OR

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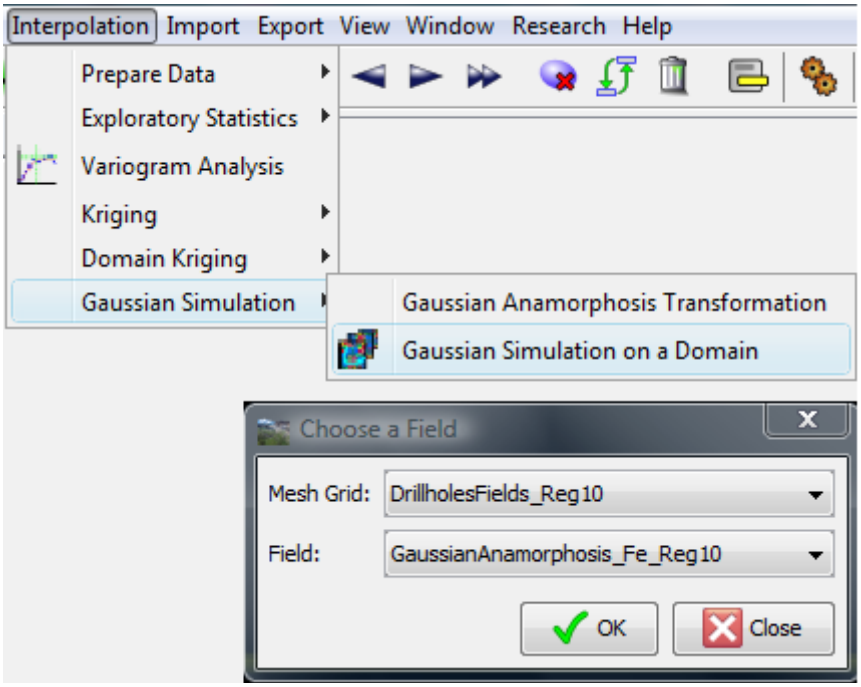
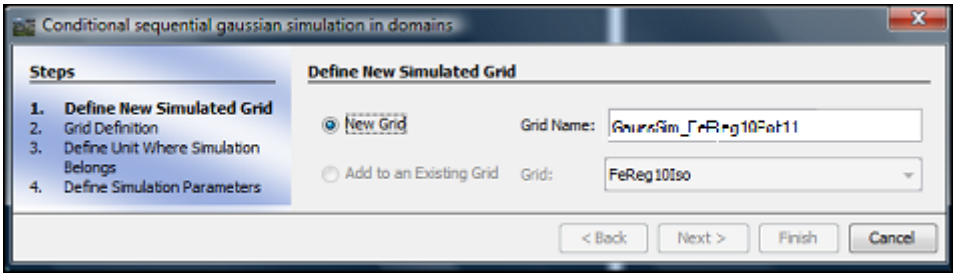
- Select **Gaussian Simulation** then **Gaussian Simulation on a Domain** from the **Interpolation** drop down in the **Main** menu



- Choose the **Mesh Grid** and **Field** to be simulated.
- Click OK

- **Step 5. Define New Simulated Grid (Step 1. in Simulation Dialog)**
  - Define the Grid name to hold the new simulated Fields



- **Step 6. Grid Definition (Step 2. in Simulation Dialog)**
  - Define the Grid neighbourhood for the Simulated grid
    - Grid Cell Sze Fixed or Variable
    - 3D limits

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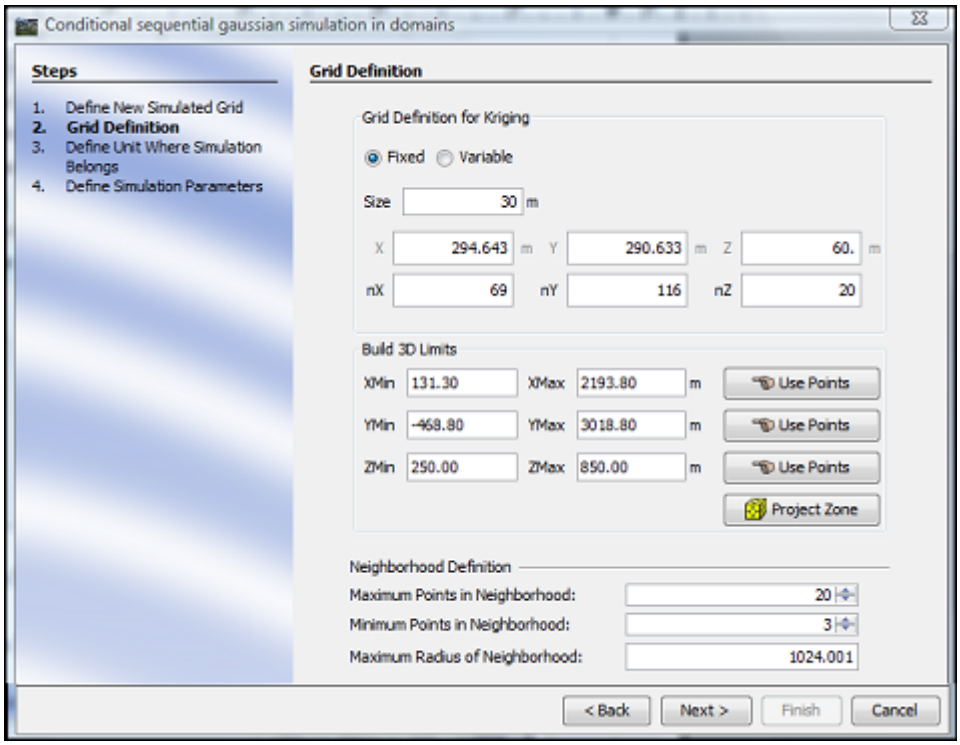
- Define the Neighbourhood search parameters
  - **Maximum Points in neighbourhood**: The algorithm does a radial search for points from the centre of the cell to be interpolated. It stops searching once the Maximum Points limit is reached. Limiting the Maximum Points in the neighbourhood minimises smoothing if the local data mean is known to fluctuate considerably and also speeds up matrix inversion.
  - **Minimum Points in neighbourhood**: The minimum number of points in the radial search required to calculate a value for the cell. If the minimum is not reached then the cell value is set to Null.
  - **Maximum Radius of Neighbourhood:** The maximum radial search distance used to scan for points to include in the estimation of a cell value.
  - **Anisotropic Ratio:** This parameter is not currently relevant to this procedure and should be left as the default of 1.
  - Click **Next >** to continue to next **Step (Step 3 in Simulation Dialog)**



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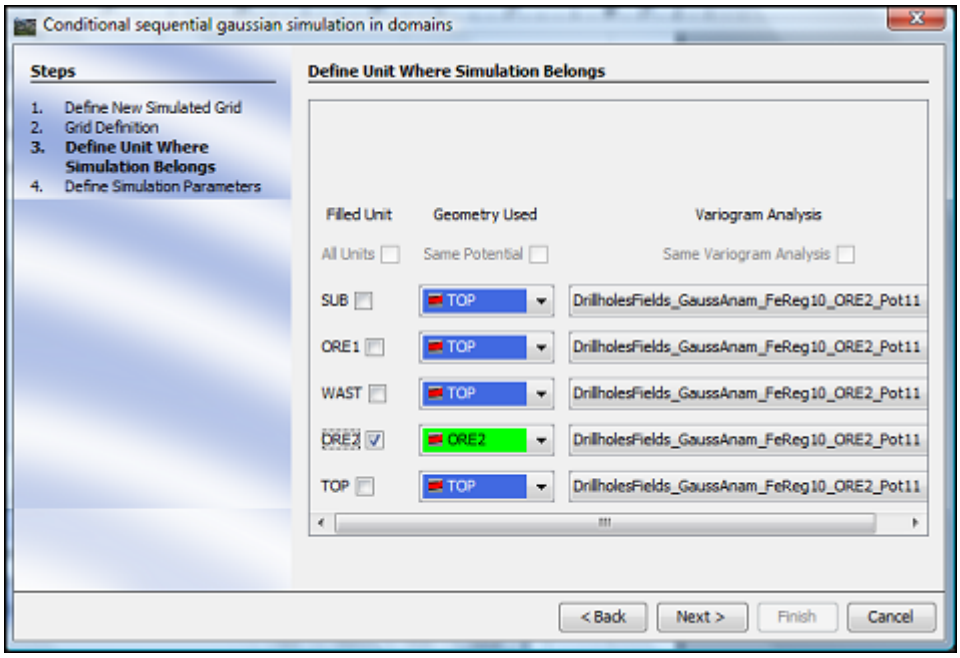
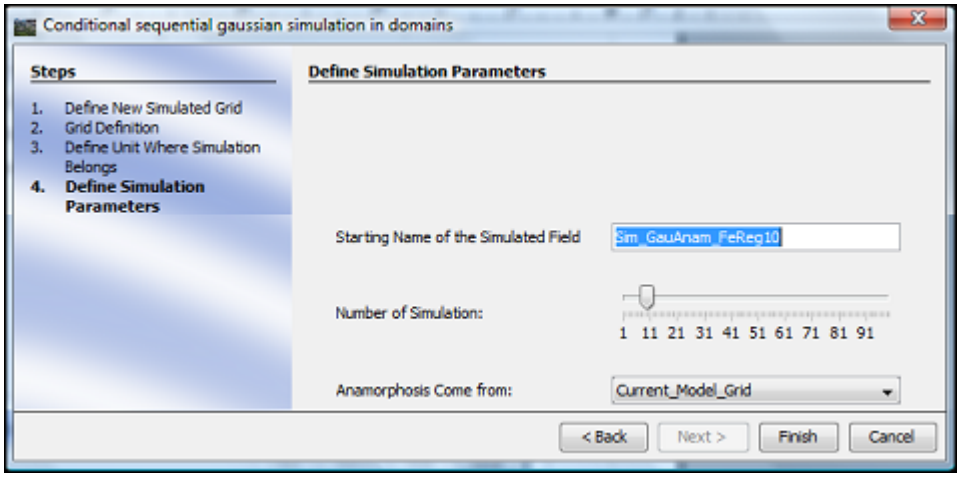
- **Step 7 - Define Domain (Unit) within which the Simulation will be computed and the variogram model that will be used.**



- **Step 8. Define the Simulation Parameters (Step 4 in Simulation Dialog)**
  - Enter **Starting Name of the Simulated Field**
  - Choose the **Number of Simulations**
  - Select the observaion Field from which the Anamorphosis was derived - **Anamorphosis Come From** ie **Fe_Reg10**



  - Click **Finish** to start the Simulation calculations

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3D GeoModeller Operations

Parent topic: 3D GeoModeller Reference

This section contains instructions for 3D GeoModeller operations

In this section:

- Organising the 3D GeoModeller workspace
- Points list operations
- Project and file operations
- Topography and section operations
- Geology formations and series operations
- Structural data operations
- Model operations
- Geophysics operations
- Importing drillholes and drillhole geophysical logs and assays

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Organising the 3D GeoModeller workspace

Parent topic: 3D GeoModeller Operations

For reference information about this area, see:

- User interface overview
- 3D GeoModeller workspace

In this section

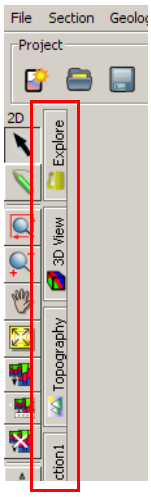
- Sizing windows
- Tabbed and separate windows
- Rearranging windows

Sizing windows

Parent topic: Organising the 3D GeoModeller workspace

Minimising

The following illustration shows all windows minimised.



You can minimise:

- Single pane windows
- Tabbed windows

Controls in the title bar: **Minimise**, **Maximise**, **Close** and **Restore**

Restoring

You can restore:

- Temporarily from minimised state
- Permanently from minimised state
- From maximised state

Controls in the title bar: **Minimise**, **Maximise**, **Close** and **Restore**

>> To restore a minimised window:

1. *(Temporary)* Point to the window's icon. 3D GeoModeller temporarily displays the window.
2. *(Permanent)* Use **Restore** in the title bar OR double click the window title.

Maximising

You can maximise:

- Single pane windows
- Tabbed windows

Controls in the title bar: **Minimise**, **Maximise**, **Close** and **Restore**

Closing windows

Close windows using the **Close** button

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Tabbed and separate windows

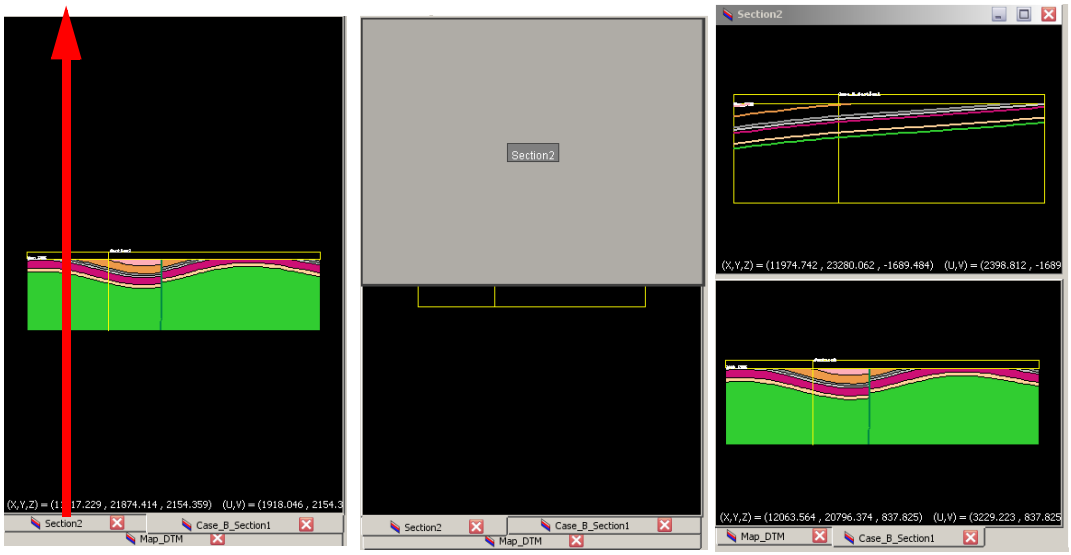
Parent topic: Organising the 3D GeoModeller workspace

Selecting a tabbed window

- To select a pane in the **2D Viewer**, select the relevant tab

Removing a window from a set of tabbed windows

To open a window tab in a new window, drag the window tab to any window edge. A 'new window' icon activates. Drop the tab into the new window.



1 2 3

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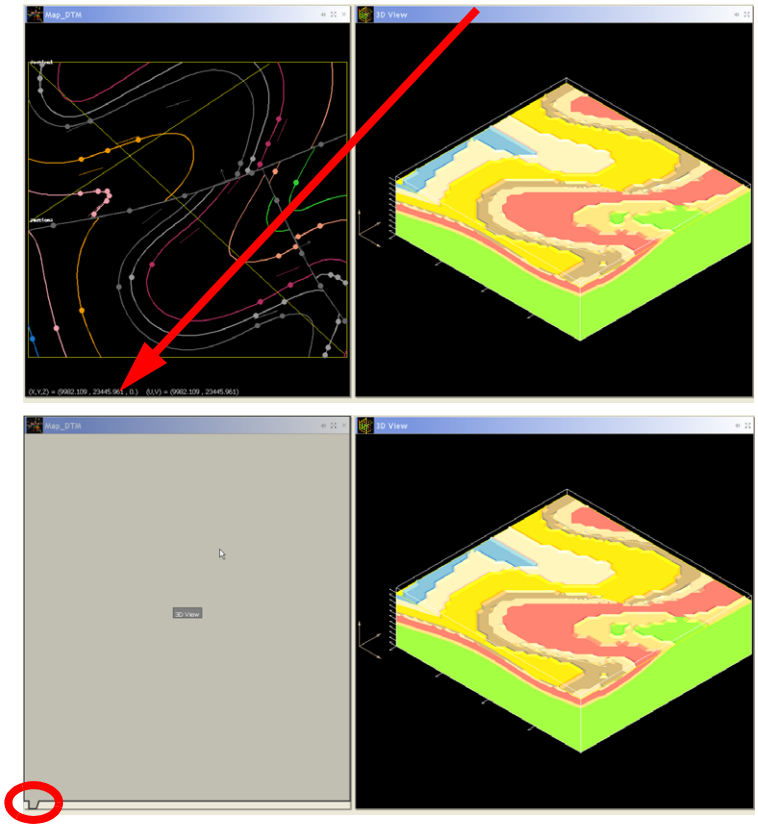
Adding a window to a set of tabbed windows

Drag any window display onto any other window space.

The two window displays will share that window space. Window tabs are created.



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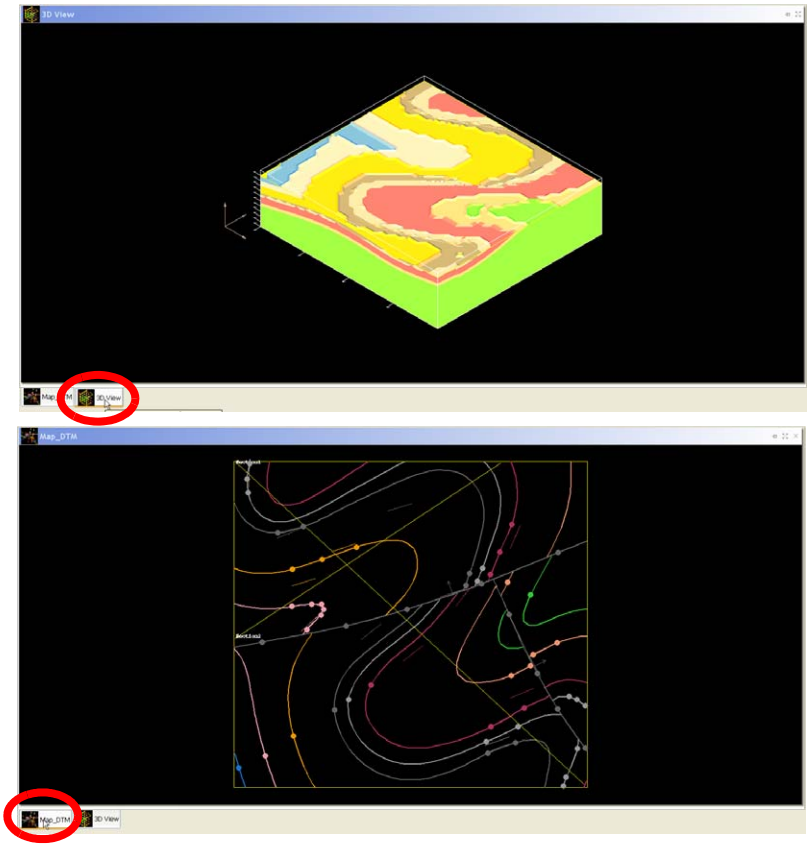
Use these to toggle between alternative displays.



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Rearranging windows

Parent topic: Organising the 3D GeoModeller workspace

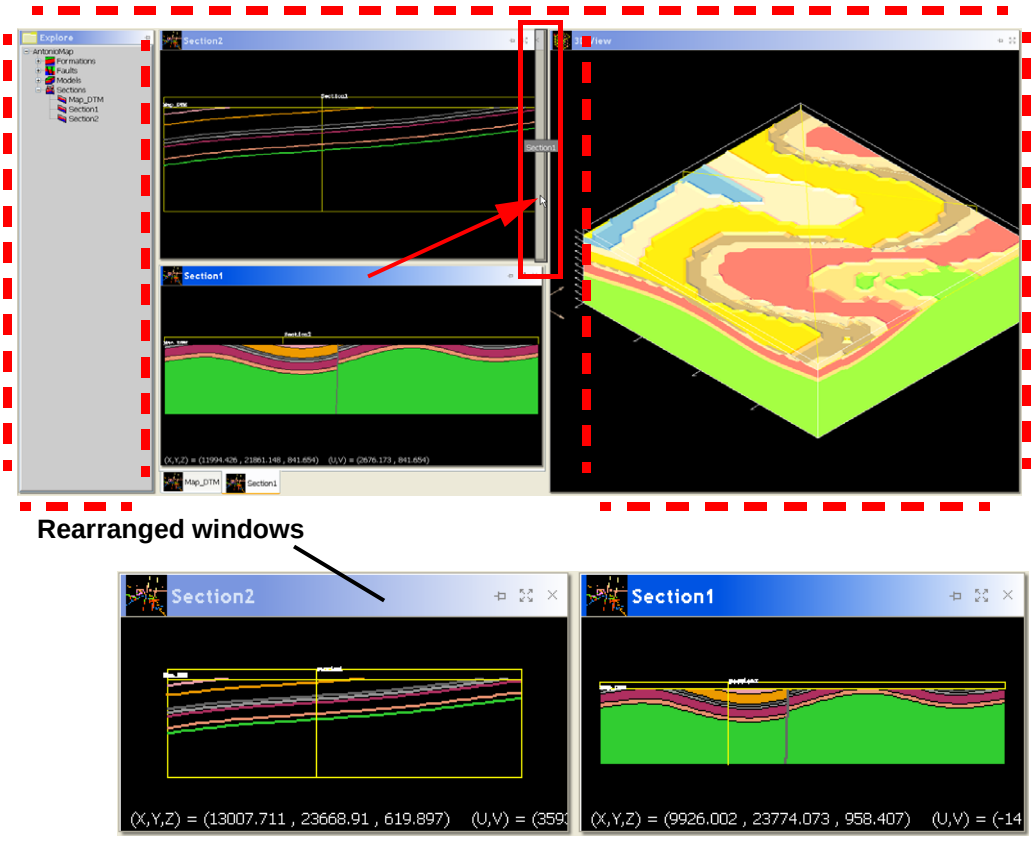
Window Edges

Drag any window edge to adjust the display of two adjacent windows

Rearrange Windows

To rearrange the window displays, drag any window title to any window edge and then drop. In the following diagram:

- The dotted red lines show possible target edges to where you can drag a window.
- The red arrow shows an example. We move the lower **2D Viewer** window so that it is beside the upper **2D Viewer** window.
- The image at the bottom shows the new positions of the two **2D Viewer** windows



Points list operations

Parent topic: 3D GeoModeller Operations

For reference information, see Points List.

In this section

- Adding a set of points to the Points List

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Adding a set of points to the Points List

Parent topic: Points list operations

In the **Points List:**

- To activate the Create mode: In the **2D Viewer** toolbar, choose **Create** . The mouse cursor changes to a cross +.
- To exit from Create mode: Choose **Select** . The mouse cursor changes to an arrow.

For information about the way 3D GeoModeller displays the contents of the Points List in the **2D Viewer**, see How the Points List coordinates with the 2D Viewer.

>> To add points to the Points List:

1. Enter Create mode
2. Select a 2D section to contain the points
3. Click a series of points in the 2D section view. 3D GeoModeller creates a points list.
4. Create project data using the points. For more information, see Editing geological data with the Points List.

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Project and file operations

Parent topic: 3D GeoModeller Operations

For reference information, see:

- The project
- Project menu, Project toolbar and dialog boxes

In this section

- Creating a project
- Recovering a saved project

Creating a project

Parent topic: Project and file operations

Main Menu: **Project > New**

To create a new project is to define the 3D work-space within which you will manage the geology map, the sections and all the other elements that will be used in the construction of the 3D model.

Complete the parameter fields according to the details of your project.

The new project also defines the structure within which you gather together all of the (input) data and the various outputs built from the computed model (section plots of model geology, 3D shapes, etc.). All of these data objects of the project are managed in a tree-structure which is presented in a special window, the **Project Explorer**.

Notes

- 3D GeoModeller can have only one project open at a time. If you want to save a version of your project or to work on a new project, save your current project work before loading the next one.
- The projects extents (the 'bounding box is modifiable as long as a topographic surface has not been defined. Once a topographic surface is defined, the topographic surface cannot be modified, and the bounding volume is fixed.

For reference information, see:

- Create new project
- Save a project (and Save As ...)
- Project Properties dialog box

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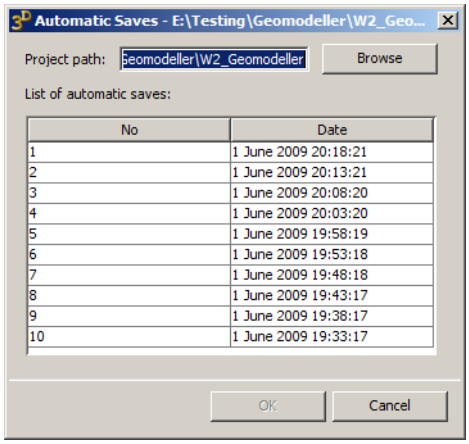
Recovering a saved project

Parent topic: Project and file operations

Using this option you can select a copy of an autosaved saved project and restore it.

When you choose **File > Autosave > Recover Saved Project** the **Automatic Saves** selection dialog box appears.

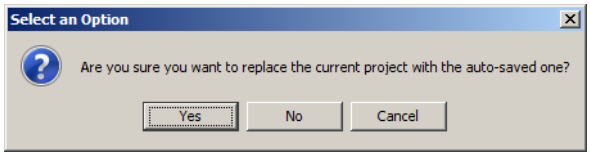


>> To recover the project if it is still open

Recovery points for the current project are displayed in reverse chronological order (youngest to oldest).

1 Select the row **No Date Time** that is to be restored and choose **OK**.

3D GeoModeller displays the following dialog box:



2 Choose **Yes** to overwrite the currently loaded project

>> To recover the project if the computer crashed or 3D GeoModeller locked up or crashed

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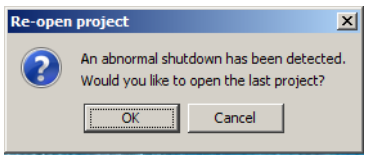
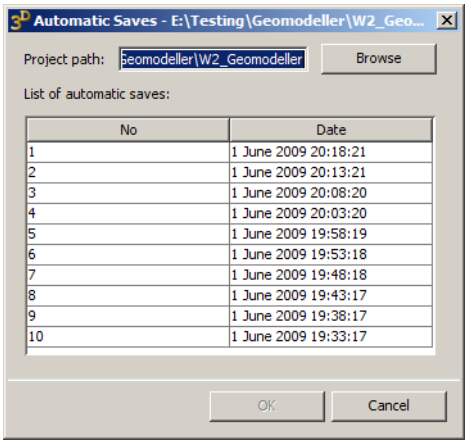
When you restart 3D GeoModeller, the following dialog box appears



1 If you are satisfied that the most recent save of the project to be restored is complete then choose **OK**. 3D GeoModeller restores the most recent save.

If you had not saved the model for some time before the abnormal shutdown then choose **Cancel** and then choose **File > Autosave > Recover Saved Project** and go to step 2.



2 Select the most recent autosave from the top of the list and choose **OK**.

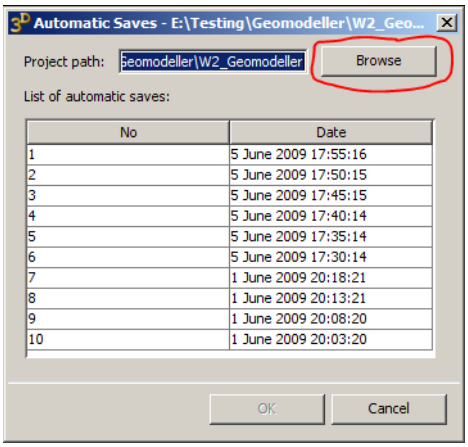
>> To restore a project from a different folder

In some circumstances the last project that you worked on may not be the one that you want to recover. For example, you may have recently saved the project to a new name using **Save As**. To restore an Autosave for the project from another folder:

1 Choose **File > Autosave > Recover Saved Project**

2 Use **Browse** to navigate to the project directory you require

3 Select the automatic save you require and choose **OK**.



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Topography and section operations

Parent topic: 3D GeoModeller Operations

For reference information about this area, see:

- The topographic surface
- Sections
- Section menu, toolbar and dialog boxes

In this section

- Defining the topographic surface
- Creating a section
- Using the Tape Measure

Defining the topographic surface

Parent topic: Topography and section operations

- Main Menu: **Section > Topography > Load from a DTM** (using an ASCII file. See File Formats—Digital terrain model)
- Main Menu: **Section > Topography > Define as an horizontal plane** (if you want a simple horizontal planar topography at a specified elevation or RL)

The topographic surface is essential in a project. It defines the upper limit of the 3D geology model; the 'geology map' for your project area is created from the intersection of this topographic surface and the (mathematical) 3D model.

Creating a section

Parent topic: Topography and section operations

- **2D Viewer** shortcut menu: **Section > Create a section from its trace** (if you defined its trace on the topography or in another section - using the Points List)
- **2D Viewer** shortcut menu: **Section > Create a Horizontal Section** (if you want to create a horizontal planar section)

To create a section 'from its trace' first draw the trace of the required section-line on topographic surface (or in another section view) using the **Points List**.

In a **2D Viewer**, a section is presented in its 2D space. True 'along-line' distances are preserved; the section is **not projected** onto the **2D Viewer** plane.

This transformation implies a change of coordinate system [(x, y, z) to (u, v)]. By default the coordinates of the 1st point of the trace of the section in 2D space are fixed at u = 0 and v = z (i.e. v = z= its height or RL). Note: u is the section's x-axis, v is the section's y-axis (typically a 'height'-axis).

In the dialog box for the creation of a section, you can modify the coordinates for this section-origin point; Once the section has been created, however, no further modification is allowed.

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Using the Tape Measure

Parent topic: Topography and section operations

With the **Tape Measure** you can measure distances and angles in a section.

>> To use the Tape Measure:

1. In the **2D Viewer** select the section in which you want to use the **Tape Measure**
2. Select the **Tape Measure** tool . 3D GeoModeller displays the **Tape Measure** window. See Tape Measure.
3. To view all data, choose **More**. To view only the distance, bearing and angle, choose **Less**.
4. Click the starting, intermediate and end points of the path you want to measure.
5. Read the results in the **Tape Measure** window.
6. When finished, close the window using **Close** in the top right corner.
7. To clear the path and start measuring again with different points, choose **Clear**.

Geology formations and series operations

Parent topic: 3D GeoModeller Operations

For reference information about this area, see

- Geology objects—formations, faults, axial series and surfaces
- The stratigraphic pile
- Geology menu and dialog boxes

You can:

- Creating geology formations
- Editing geology formations
- Deleting geology formations

Creating geology formations

Parent topic: Geology formations and series operations

>> To create geology formations

1. From the main menu, choose **Geology > Formations > Create or Edit**. The **Create or Edit Geology Formations** dialog box appears. See Create or Edit Geology Formations dialog box.
2. Enter the name of the geology formation in the **Name** field.
3. Select the colour for the formation. Click the **Colour** field and select the colour from the **Colour Palette** dialog box. See Colour Palette dialog box.
4. Choose **Add**.
5. Repeat steps 2–4 as required.
6. Choose **Close**.

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Editing geology formations

Parent topic: Geology formations and series operations

>> To edit geology formations

1. From the main menu, choose **Geology > Formations > Create or Edit**. The Create or Edit Geology Formations dialog box appears.
2. Select (click) the formation that you want to edit.
3. Choose **Attributes** to edit the attributes of the formation. Use the Project Properties dialog box.
4. Choose **Appearance** to edit the appearance of the formation. Use the Appearance of objects dialog box family.
5. Repeat steps 2–4 as required.
6. Choose **Close**.

Deleting geology formations

Parent topic: Geology formations and series operations

>> To delete geology formations

1. From the main menu, choose **Geology > Formations > Create or Edit**. The Create or Edit Geology Formations dialog box appears.
2. Select (click) the formation that you want to delete.
3. Choose **Delete**.
4. Confirm that you want to delete the formation.
5. Repeat steps 2–4 as required.
6. Choose **Close**.

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Creating the stratigraphic pile

Parent topic: Geology formations and series operations

Main menu: **Geology > Stratigraphic Pile: Create or Edit**

- Set the Reference (Top/Bottom) of the stratigraphic pile (i.e. specify that geology data points will define the 'Top' of a geology formation, or the 'Bottom' of the formation).
- Using the geology formations previously defined, group formations into geology series, and assemble these series into the stratigraphic pile for the project. Formations and series must be arranged in their correct stratigraphic order - from the oldest (at the bottom of the stratigraphic pile) to the youngest strata (at the top).
- For each series, specify the Relationship (to older series) to be either 'OnLap' or 'Erode'. (Defined on the basis of observed rock-relationships in the field: conformable contracts, unconformities, intrusive contacts, etc.).

Structural data operations

Parent topic: 3D GeoModeller Operations

For reference information about this area, see

- Structural data
- Geology menu and dialog boxes

The inputting of geology on the map or in sections consists of creating the structural data—geology data (contacts and fault locations), geology orientation data, fold axial surface data (axial traces), axial surface orientation data (locally, the axial plane) and hingelines—which 3D GeoModeller uses to compute the 3D model:

In this section:

- Creating geology data
- Creating geology orientation data
- Fitting a plane to Points (create orientation data)
- Creating faults
- Linking faults with geology series
- Defining a network of faults
- Creating axial series
- Creating axial surfaces
- Creating axial surface data (axial traces)
- Creating axial surface orientation data
- Creating hinge line data

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Creating geology data

Parent topic: Structural data operations

Structural toolbar: **Create geology data**

When you have geology contacts (or interfaces), or fault locations, known from outcrops, etc., you can input these geology observations on the map view or in a section view. These data will then be used, together with other structural data, to compute the 3D geometrical model.

You can input geology data points either one by one, or as a group of data points (provided that all points belong to a single geology surface, such as the 'top of a formation', or a specific fault).

To create geology data points:

- Using the **Points List**, mark one or more points to define the position of a given geology feature on the map view or in a section.
- In the **2D Viewer** toolbar choose **Create geology data**.

Creating geology orientation data

Parent topic: Structural data operations

Structural toolbar: **Create geology orientation data**

You can input or edit geology orientation data on a map view or in a section. This information will be used, together with other structural and geology data, to compute the 3D geometrical model.

Geology orientation data are input individually, one point at a time.

To create geology orientation (structural) data (dips and dip directions, as orientation data points):

- Using the **Points List**, mark either one point (a position only) or two points (defining position and dip direction) on the map view or in a section.
- In the **2D Viewer** toolbar choose **Create geology orientation data** .

Fitting a plane to Points (create orientation data)

Parent topic: Structural data operations

Structural toolbar: **Fit a plane to points**

This button computes the dip and the dip direction of a plane 'fitted' through several points. This is useful when you have outcrops of a formation, or the limits of this formation on the DTM, but have no dip and dip direction measurements. For this computation, 3D GeoModeller 'fits' a plane (representing the average geological surface) through the listed points.

The resulting orientation value (dip and dip direction) can be used to create new orientation data either at all of the Points, or at a single point (defined either by inputting coordinates, or using the Current Point of the **Points List**). In both cases, the selected points used for the calculation, or the single point to be assigned the 'result', are transformed into orientation data, identical to any other (measured) orientation data point.

Creating faults

Parent topic: Structural data operations

Main menu: **Geology > Faults: Create or Edit**

- Input the name of the fault.
- Choose its colour by clicking in the coloured zone. The 'RGB' tab on the colour-pallet allows you to set a specific colour by choosing numerical RGB value.

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Linking faults with geology series

Parent topic: Structural data operations

Main menu: **Geology > Link faults with series**

This dialog box defines the influence of a fault on each series of geology formations. To do this, use the table and mark [x] to define which fault affects which series.

Series are defined during the process of defining the stratigraphic pile.

Defining a network of faults

Parent topic: Structural data operations

Main menu: **Geology > Link faults with faults**

With this function you can specify that one fault stops on another. Using the table, you can define a 'network' of faults.

Creating axial series

Parent topic: Structural data operations

Main menu: **Geology > Axial series > Create or Edit**

To create a new axial series:

1. Input the name of the series
2. Choose the colour by clicking on the coloured zone. The **RGB** tab on the colour palette allows you to set a specific colour by choosing numerical RGB values.
3. Confirm by choosing **Add**.

Creating axial surfaces

Parent topic: Structural data operations

Main menu: **Geology > Axial surfaces > Create or Edit**

To create a new axial surface:

- Input the name of axial surface
- Choose the colour by clicking on the coloured zone. The **RGB** tab on the colour palette allows you to set a specific colour by choosing numerical RGB values.
- Choose the type of fold (**Anticline** or **Syncline**)
- Select the associated axial series. If this axial surface cannot be associated with any of the existing axial series, you can create a new one by choosing **New axial series**
- Choose **Add**.

Creating axial surface data (axial traces)

Parent topic: Structural data operations

Structural toolbar: **Create axial surface data (Axial traces)**

When you know (from outcrop) the trace of a fold axis, you can input this on a map or a section view. This information will be used, together with other structural and geology data, to compute the 3D geometrical model.

To create axial surface data (an axial trace):

- With the **Points List**, input the points defining the position of the fold axis on the map or section view.
- In the **2D Viewer** toolbar choose **Create axial surface data (Axial traces)** .

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Creating axial surface orientation data

Parent topic: Structural data operations

Structural toolbar: **Create axial surface orientation data**

You can create or edit axial surface orientation data (measurements of the axial plane) on a map or a section view. This information will be used, together with other structural and geology data, to compute the 3D geometrical model.

Axial surface orientation data are created one point at a time.

To define axial surface orientation data (locally, an axial plane):

- With the **Points List**, place a single point (for position only), or two points (for position and direction) on the map or section view
- In the **2D Viewer** toolbar choose **Create axial surface orientation data** .

Creating hinge line data

Parent topic: Structural data operations

Structural toolbar: **Create hinge line data**

When you know (from outcrop) the hinge line of a fold, you can input this on a map or a section view. This information will be used, together with other structural and geology data, to compute the 3D geometrical model.

To create a hinge line:

- With the **Points List**, input points which define the hinge line on the map or a section view.
- Choose **Hinge line** in the **Structural** toolbar.

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Model operations

Parent topic: 3D GeoModeller Operations

For reference information about this area, see

- The 3D model
- Model menu, toolbar and dialog boxes

In this section:

- Computing the 3D model
- Plotting the model in a section
- Building 3D shapes (of model geology)
- Tips for faster model plotting

Computing the 3D model

Parent topic: Model operations

Main menu: **Model > Compute**

Having created or loaded geology data (and geology orientation data, faults, fold axial data, ...), you can compute the 3D geometrical model.

Plotting the model in a section

Parent topic: Model operations

2D Viewer toolbar: **Plot the model**

Having computed the 3D model, you can plot (render, or draw) the model-geology on the topographic surface (map) or any other section. In effect, this plot is simply the intersection between the (mathematical) model and the selected map or section.

Building 3D shapes (of model geology)

Parent topic: 3D GeoModeller Operations

Main menu: **Model > Build 3D formations and faults**

Having 'computed' a (mathematical) model from the geology and structural data of your project, you can 'build' various forms of 3D shapes of the model geology for each of the formations of the project. When built, these 3D 'shapes' will be rendered in the **3D Viewer** (see 3D Viewer). The displayed shapes will vary, according to the 'type' of 3D shape built; '3D Volumes', for example, will be rendered as closed volumes for each formation, each defined by triangulated surfaces.

Tips for faster model plotting

Parent topic: 3D GeoModeller Operations

A large project that contains a lot of data may take time to plot. These tips will help you reduce the time required.

- Only plot on the section intersections. This may give you a satisfactory view of the model. See the option in Model menu, toolbar and dialog boxes.
- Limit the plotted area. See the **Plotting limits** controls in Plot the Model Settings dialog box.
- Reduce the density of imported GIS and binary located data. See **Filtering (threshold)** in Importing GIS and other binary located data.

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Geophysics operations

Parent topic: 3D GeoModeller Operations

For reference information about this area, see Geophysics menu and dialog boxes

In this section:

- Defining physical properties for a formation
- Computing a 2.5D forward model

Defining physical properties for a formation

Parent topic: Geophysics operations

Before performing geophysics operations, you need to define geophysical properties of the formations involved.

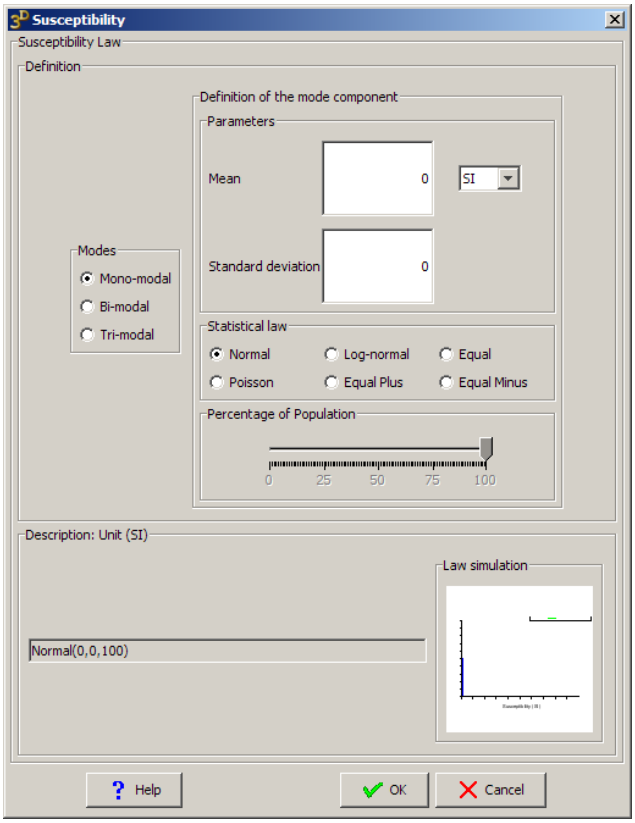
>> To define geophysical properties:

1 From the main menu choose **Geophysics > Define physical properties**. See Geophysics menu and dialog boxes.

The **Physical properties of geological formation** dialog box appears. See Physical Properties of Geological Formation dialog box.

2 Select the tab you require: **Gravity**, **Magnetic**, **Thermal** or **Seismic**.

3 Double click the cell of the table corresponding to the formation and property you want to configure. The dialog box for the property appears.



4 Set the **Statistical law**, **Mode**, **Parameters** and **Percentage of population** parameters as required.

For example, **Statistical law:** Log-normal, **Mean:** .05, **Standard deviation:** .05.

5 Repeat steps 3–4 for other tabs as required

6 Choose **OK**.

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Computing a 2.5D forward model

Parent topic: Geophysics operations

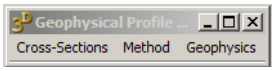
Using 3D GeoModeller you can quickly compute 2.5D gravity and magnetic forward models for a chosen project cross section.

>> To compute a 2.5D forward model:

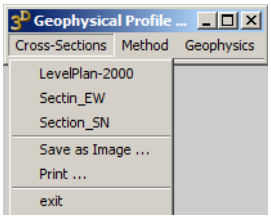
1 Ensure that you have defined physical properties for at least one formation. For instructions, see Defining physical properties for a formation.

2 From the main menu choose **Geophysics > 2D Geophysics**. See Geophysics menu and dialog boxes.

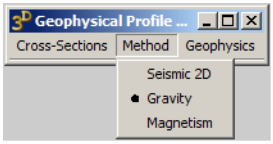
The **Geophysical profile computer** appears



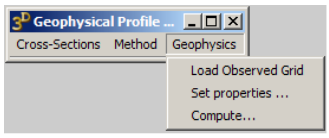
3 From the **Geophysical profile computer**'s **Cross-Sections** menu choose the project section you require.

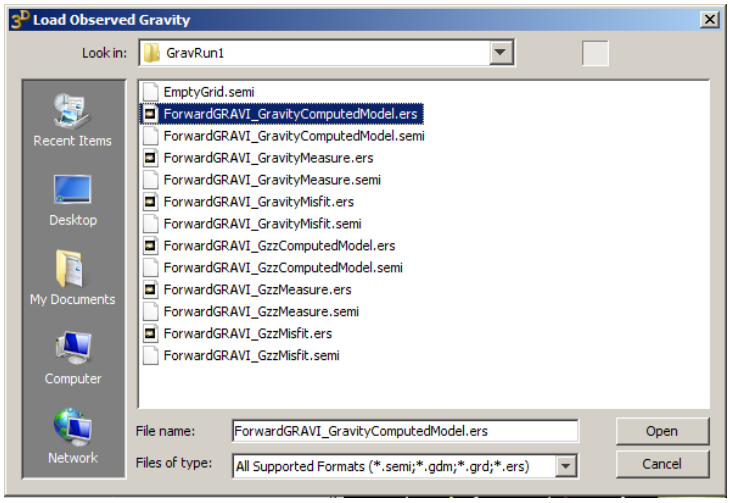


4 From the **Geophysical profile computer**'s **Method** menu choose **Gravity** or **Magnetics**



5 *(If you want to load a grid of observations)* From the **Geophysical profile computer**'s **Geophysics** menu choose **Load observed grid**





This enables you to load an observed or 3D forward modelled gravity or magnetics grid. 3D GeoModeller samples a profile from the grid along the chosen section for comparison with your 2.5D forward model.

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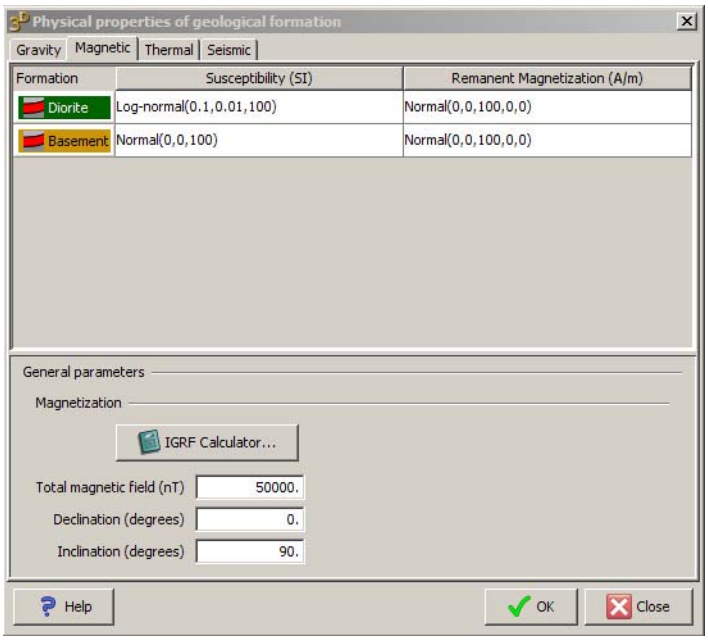
6 *(If you want to set further physical properties of formations)* From the **Geophysical profile computer**'s **Geophysics** menu choose **Set properties**.

The **Physical properties of geological formation** dialog box appears. See Physical Properties of Geological Formation dialog box.

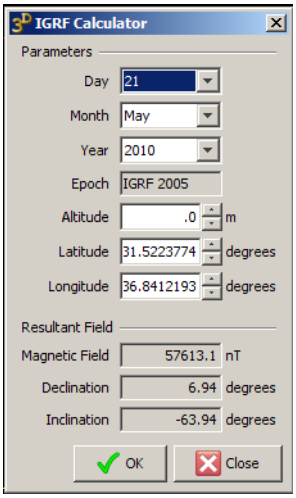
Set the properties as required.

Note that 3D GeoModeller does not retain the magnetic IGRF settings from one session to the next, so you need to set in each time you open your project. Follow these instructions:

The following screen snap is an example of the default IGRF setting on opening a project.



Choose **IGRF Calculator** to get the local IGRF field settings (calculated using datum, projection and coordinates of the centre of the project.



Choose **OK** to set the IGRF field properties in the **Physical properties** dialog box.

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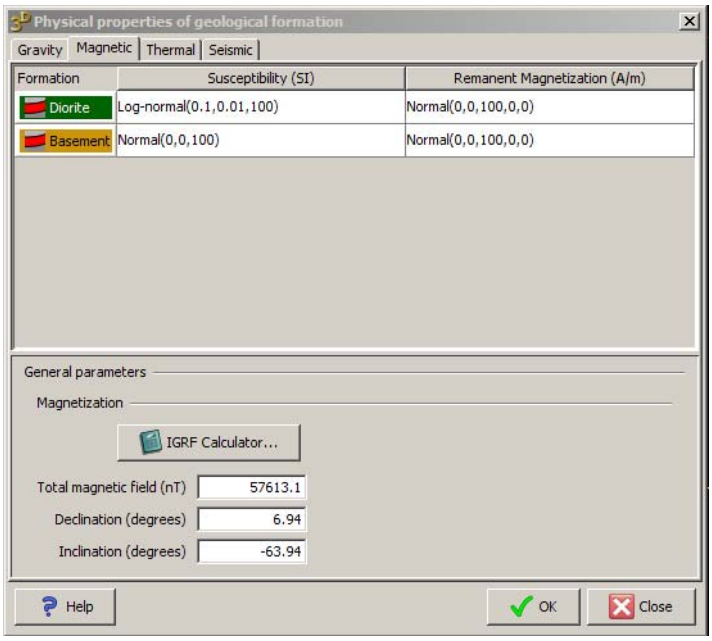
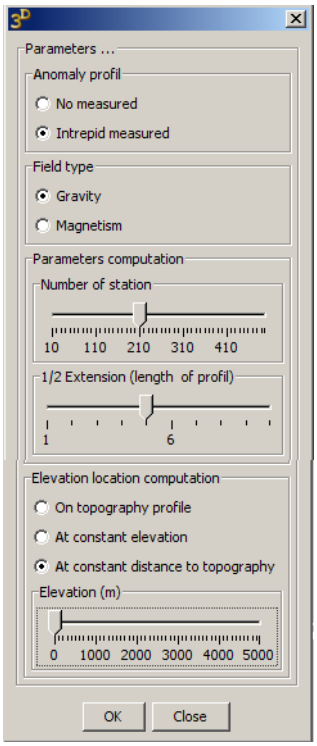


Choose **OK**.

7 From the **Geophysical profile computer**'s **Geophysics** menu choose **Compute**. The **Compute** dialog box appears



This dialog box enables you to set model computation parameters and choose whether to compare the predicted profile with the observed or modelled grid.

In the example screen shot that appears above, we have chosen to compare the profile from the forward model of the section with the profile from the observations grid that we loaded.

We did this by selecting **Intrepid measured**.

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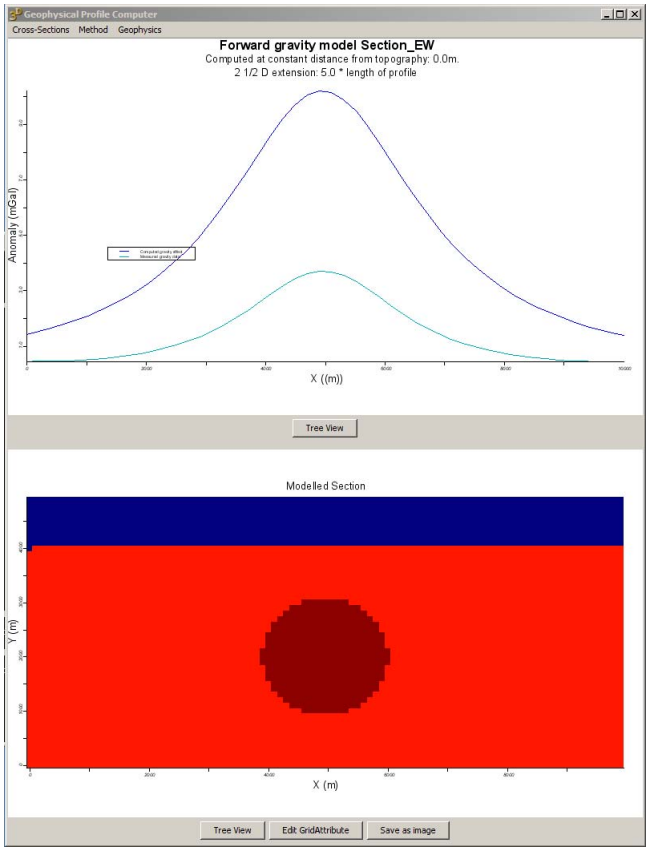
In our example, 3D GeoModeller calculates the model response at a constant distance of 0 to Topography (in other words, at the surface).

You can also specify:

- The number of stations along the modelled profile
- The half extension distance perpendicular to the section (in length of profile multiples).

8 Choose **OK**. 3D GeoModeller calculates the forward model and displays the profile in the **Geophysical Profile Computer** window.



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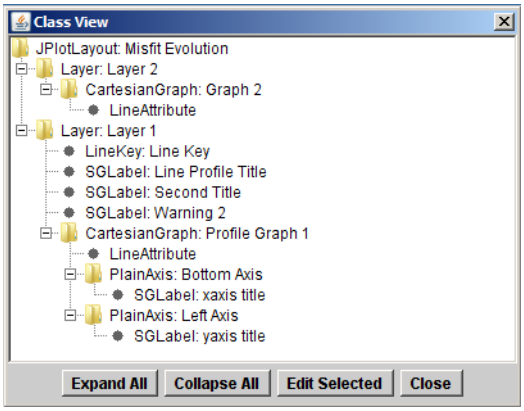
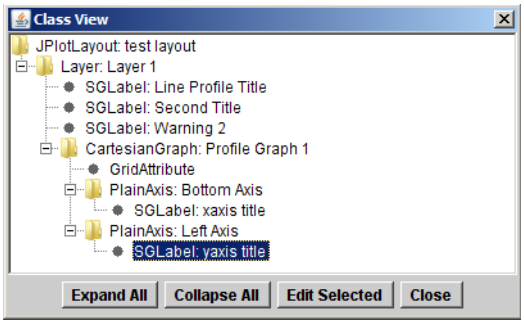
9 Edit the text items as required in the panel. Choose **Tree view**. Use the **Class View** window to edit the items.

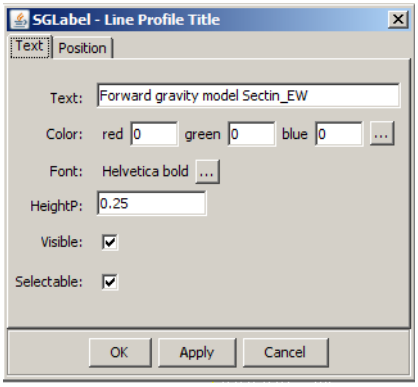


Tree View Profile panel



Tree View Section or Grid panel

When you select a label type and choose **Edit Selected,** 3D GeoModeller displays a dialog box with editing options.



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Importing drillholes and drillhole geophysical logs and assays

Parent topic: 3D GeoModeller Operations

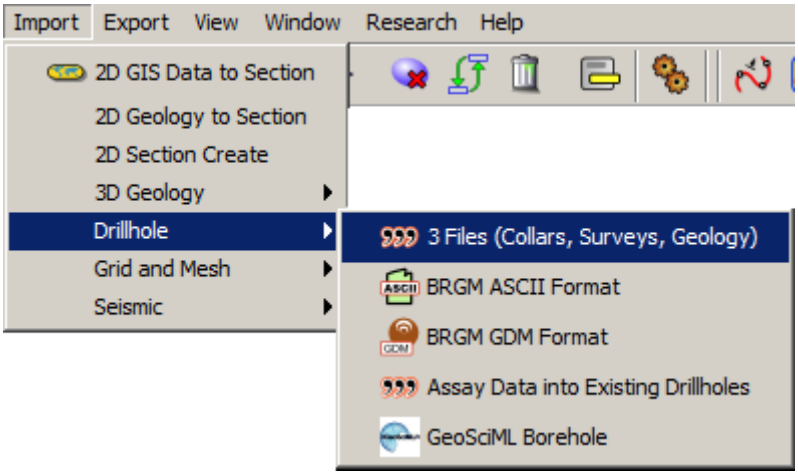
For reference information about this area, see Import menu and dialog boxes

In this section:

- Importing a set of 3 ASCII files (Collar, Survey & Geology)
- Validation rules for drillholes (3 Files CSV format)
- Importing a single BRGM ASCII file
- Importing a binary GDM data record (BRGM software format)
- Importing an XML file, formatted according to the GeoSciML standard
- Importing drillhole geophysical logs and assays into existing drillholes

Use the following menu operations:

- Main menu: **Import > Drillhole > 3 Files (Collars, Surveys, Geology)**
- Main menu: **Import > Drillhole > BRGM ASCII Format**
- Main menu: **Import > Drillhole > BRGM GDM Format**
- Main menu: **Import > Drillhole > GeoSciML Borehole**
- Main menu: **Import > Drillhole > Assay Data into Existing Drillholes**



You can import drillholes in 3D GeoModeller from four data file formats

- a set of 3 ASCII files (Collar, Survey & Geology) in TXT, TAB or CSV format
- a single BRGM style ASCII file or
- a GDM binary data record (BRGM software format).
- an XML file formatted according to the GeoSciML standard.

You can import geophysical logs and assays into existing drillholes using an ascii file in TXT, TAB or CSV format.

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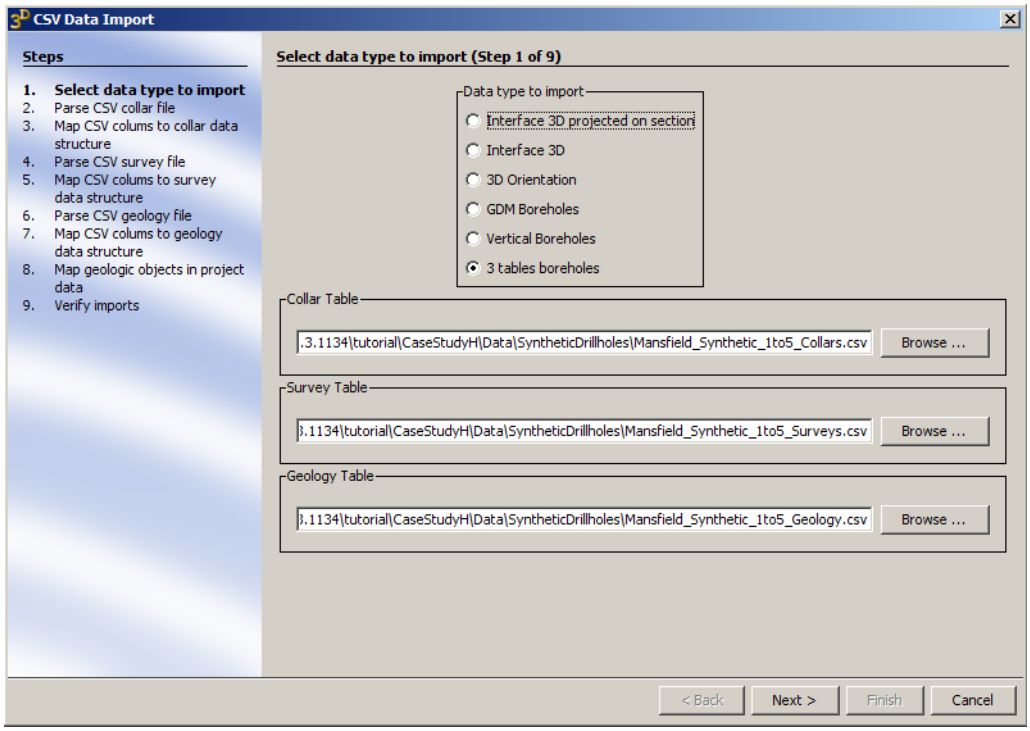
Importing a set of 3 ASCII files (Collar, Survey & Geology)

Parent topic: Importing drillholes and drillhole geophysical logs and assays

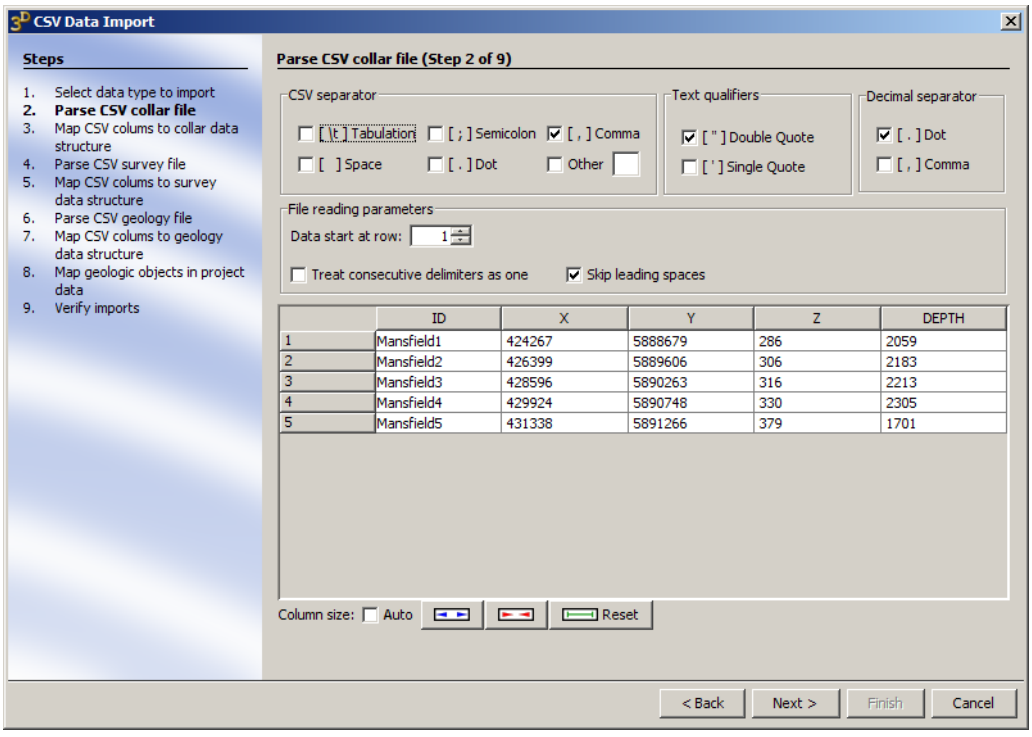
The 3 ASCII files are parsed using an import wizard similar to that provided with the Excel Data tool 'Text to Columns'. The import wizard is able to handle fixed width or space, comma or tab delimited files or a combination of both.

Examples of the first two steps in the wizard import dialogue are shown below:

1 Select the data to import



2 Parse CSV collar file


CSV Data Import
Steps
1. Select data type to import
2. Parse CSV collar file
3. Map CSV colums to collar data structure
4. Parse CSV survey file
5. Map CSV colums to survey data structure
6. Parse CSV geology file
7. Map CSV colums to geology data structure
8. Map geologic objects in project data
9. Verify imports
Parse CSV collar file (Step 2 of 9)
CSV separator
[\t] Tabulation
[;] Semicolon
[,] Comma
[ ] Space
[.] Dot
Other
Text qualifiers
["] Double Quote
['] Single Quote
Decimal separator
[.] Dot
[,] Comma
File reading parameters
Data start at row: 1
Treat consecutive delimiters as one
Skip leading spaces
ID X Y Z DEPTH
1 Mansfield1 424267 5888679 286 2059
2 Mansfield2 426399 5889606 306 2183
3 Mansfield3 428596 5890263 316 2213
4 Mansfield4 429924 5890748 330 2305
5 Mansfield5 431338 5891266 379 1701
Column size: Auto Reset
< Back
Next >
Finish
Cancel

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The 3 files contain Collar data, Down Hole Survey data and Geology data

The wizard uses a lookup table to try to automatically identify and match the field header names with the required import fields. The fields within each file can be in any order. If the files do not contain a header line then the user must select the columns for matching unless the expected order is as shown in the following examples; if so the correct matching will take place automatically.

The 3 files have the following structure:

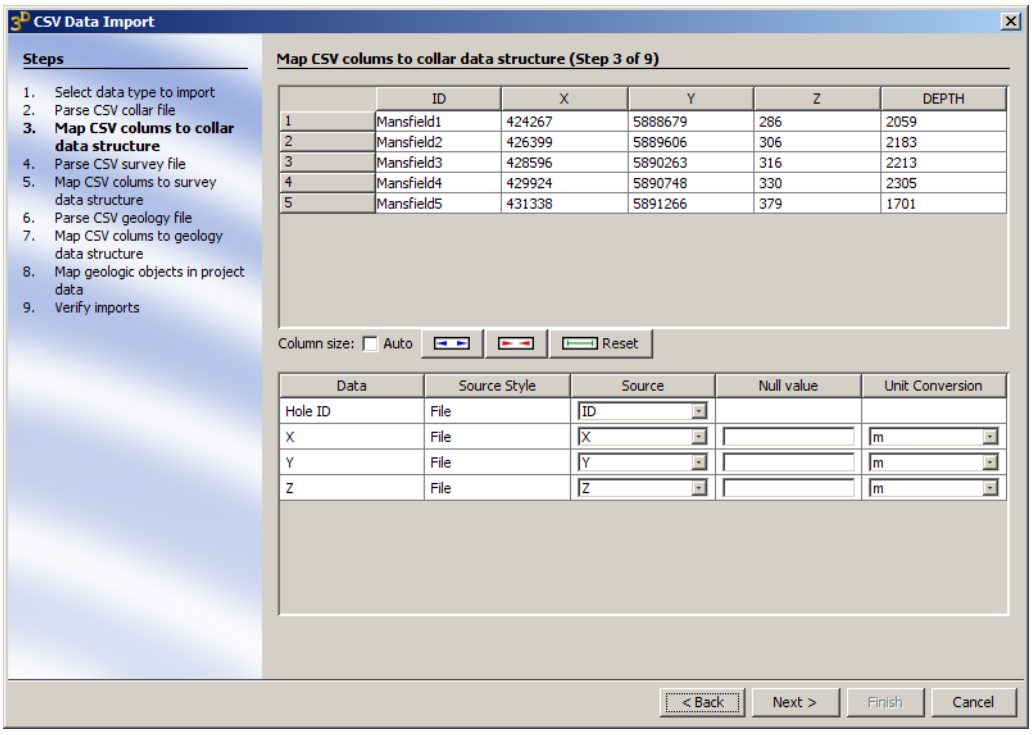
Collar file

The Collar file must contain the following fields.

Field	Description
HoleID	Name of Drillhole (Must begin with a letter).
Collar_X	East (X) coordinate of the drillhole collar.
Collar_Y	North (Y) coordinate of the drillhole collar
Collar_Z	RL or Elevation of the drillhole collar.

Example

```
HoleID,Collar_X,Collar_Y,Collar_Z
Mansfield1,424267,5888679,286
```


CSV Data Import
Steps
1. Select data type to import
2. Parse CSV collar file
3. Map CSV colums to collar data structure
4. Parse CSV survey file
5. Map CSV colums to survey data structure
6. Parse CSV geology file
7. Map CSV colums to geology data structure
8. Map geologic objects in project data
9. Verify imports
Map CSV colums to collar data structure (Step 3 of 9)
ID X Y Z DEPTH
1 Mansfield1 424267 5888679 286 2059
2 Mansfield2 426399 5889606 306 2183
3 Mansfield3 428596 5890263 316 2213
4 Mansfield4 429924 5890748 330 2305
5 Mansfield5 431338 5891266 379 1701
Column size: Auto Reset
Data Source Style Source Null value Unit Conversion
Hole ID File ID
X File X m
Y File Y m
Z File Z m
< Back Next > Finish Cancel

Other fields can exist but they will not be imported. A **`FinalDepth`** or **`EOHDepth`** is not required in 3D GeoModeller V1.3 but will be imported if present in 3D GeoModeller V2.0 to improve the validation of depths in the Survey and Geology files.

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Survey file

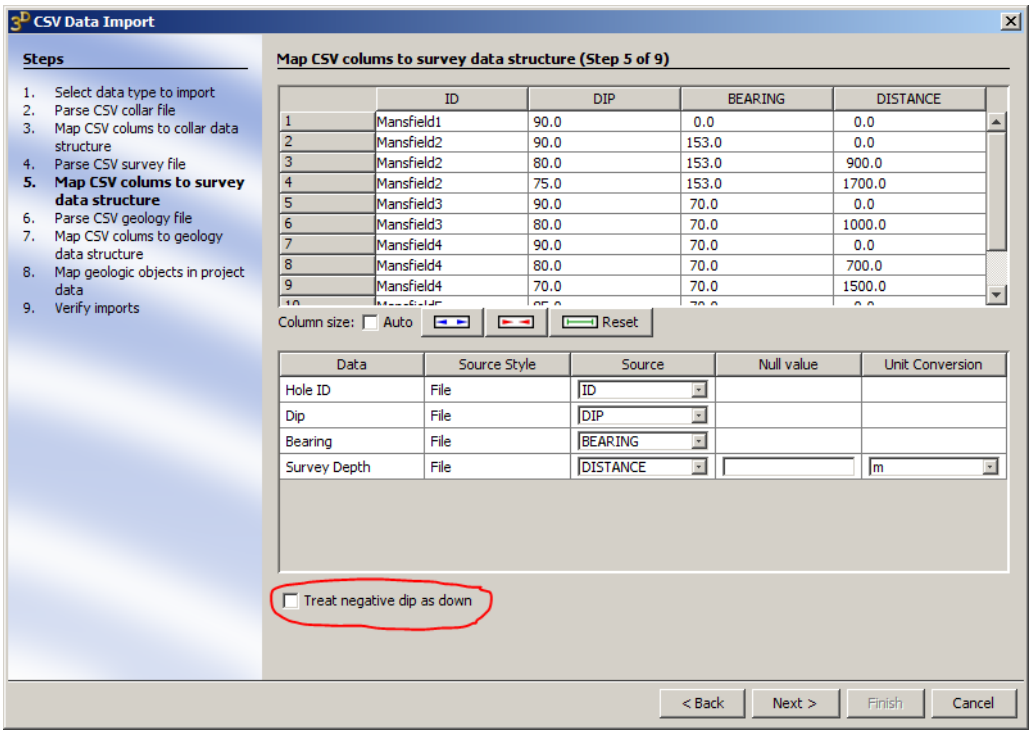
The Survey file must contain the following fields.

Field	Description
HoleID	Name of Drillhole.
Dip	Dip of the drillhole path, +ve down (+90 to -90 degrees).
Azimuth	Dip direction of the drillhole path, (0 to 360 degrees).
SurveyDepth	Distance down the drillhole path to the survey point.

Example

```
HoleID,Dip,Azimuth,DownHoleDepth
Mansfield1,90.0,0.0,0.0
```

Note: The default convention of Dip +ve down can be flipped using the toggle switch at the base of the survey dialogue window (highlighted in red below).


CSV Data Import
Steps
1. Select data type to import
2. Parse CSV collar file
3. Map CSV colums to collar data structure
4. Parse CSV survey file
5. Map CSV colums to survey data structure
6. Parse CSV geology file
7. Map CSV colums to geology data structure
8. Map geologic objects in project data
9. Verify imports
Map CSV colums to survey data structure (Step 5 of 9)
ID DIP BEARING DISTANCE
1 Mansfield1 90.0 0.0 0.0
2 Mansfield2 90.0 153.0 0.0
3 Mansfield2 80.0 153.0 900.0
4 Mansfield2 75.0 153.0 1700.0
5 Mansfield3 90.0 70.0 0.0
6 Mansfield3 80.0 70.0 1000.0
7 Mansfield4 90.0 70.0 0.0
8 Mansfield4 80.0 70.0 700.0
9 Mansfield4 70.0 70.0 1500.0
Column size: Auto Reset
Data Source Style Source Null value Unit Conversion
Hole ID File ID
Dip File DIP
Bearing File BEARING
Survey Depth File DISTANCE m
Treat negative dip as down
< Back Next > Finish Cancel

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Geology file

The Geology or lithology file must contain the following fields.

Field	Description
HoleID	Name of Drillhole.
From	Depth down drillhole path to start of litho interval.
To	Depth down drillhole path to end of litho interval.
Lithology	Formation or lithology code for the interval.

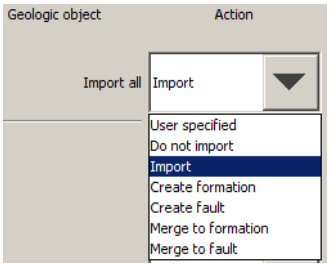
Example

```
HoleID,From,To,Lithology
Mansfield1,0.0,156.0,UpperMansfield
```

Mapping the drillhole units in 3D GeoModeller

Once the Geology file has been parsed the user is presented with a dialog box for selecting a global method for importing and mapping the drillhole Formation/Fault units within the 3D GeoModeller project.

A default global method option will be selected for the user depending on whether the imported lithologies can be automatically matched to project formations. The global method can be modified by the user to handle non matches and these can be further modified by selection from the drop down lists at the individual formation level.



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The following global import and mapping methods are available:

Option	Description
Import	Imports all drillhole lithologies that match an existing formation in the current 3D GeoModeller project. This is the default selection if all lithologies being imported are matched. See Fig 1.
User Specified	This will be the default selection if some imported lithologies do not match a formation within the 3D GeoModeller project. See Fig 2.
Do not import	If the user selects this global option all lithologies will be set to 'Do not import'. The user can modify this selection using the drop down lists at the individual formation level. **Note:** The user may be surprised to see 'Import' as the default but no formation matches when he believes the litho codes are matched by formation names. This can be caused by leading spaces in the imported lithology names and is a symptom of a poorly formatted CSV file. An example of this occurs with the CSV import files in Case Study H. In this case the user must also select a space as a separator and check **Treat consecutive delimiters as one** in the Parse CSV import steps. See Fig 5.
Create formation	This option creates a new project formation for any lithology name that does not match a project formation. See Fig 3. This is useful when importing into a new project where no formations exist. The user can modify this selection using the drop down lists at the individual formation level.
Merge to Formation	This option allows the user to merge lithology subsets to a single project formation. It will try to match lithology codes to existing formation names. If there is an exact match then it behaves like Import. If there isn't an exact match then it will try to match lithology codes set to **Do not import** to formation names containing the same leading characters. For example **BG1** and **BG2** will be matched to **BG**. See Fig 4.

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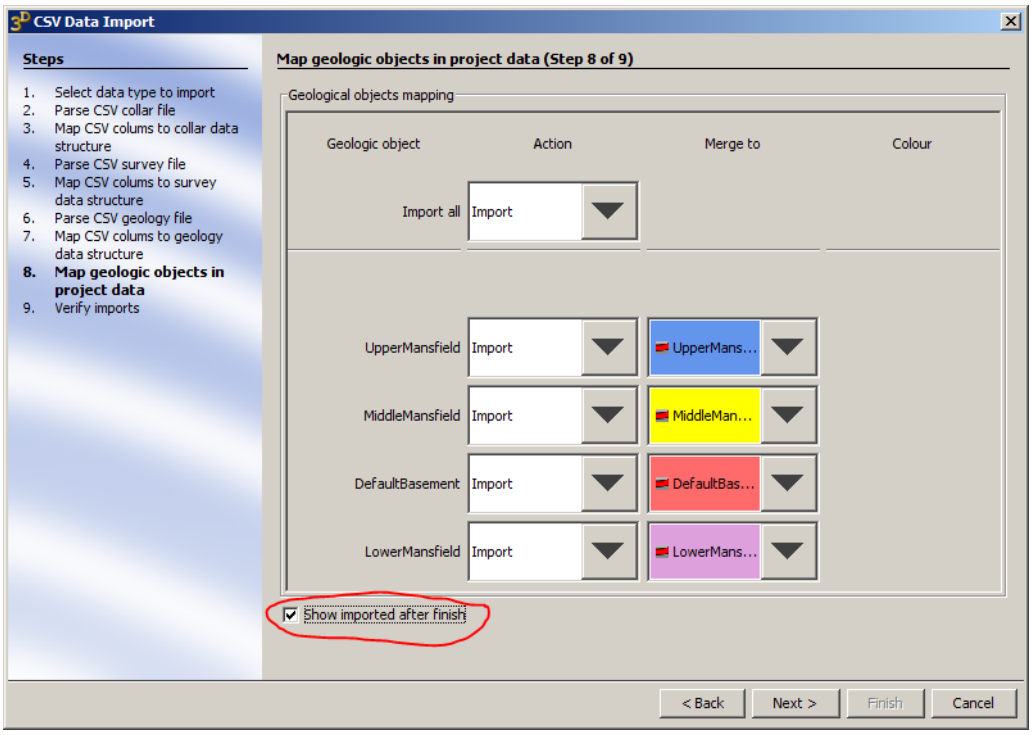
The image below is an example of the **Import** method. Import is selected by default (see Tutorial case study H (Mansfield)) because all the imported lithology/formation codes are matched to a project formation.



Note: If you check **Show imported after finish**, 3D GeoModeller displays the imported drillholes in the **3D Viewer** as soon as you choose **Finish** in the **Verify Imports** dialog box (accepts the results of the first validation report).

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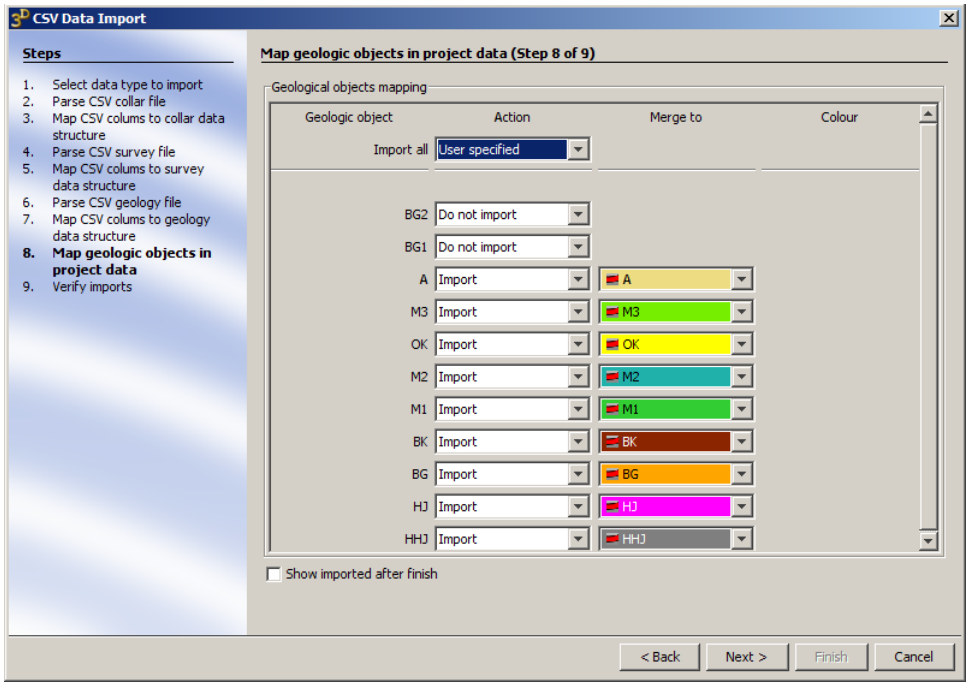
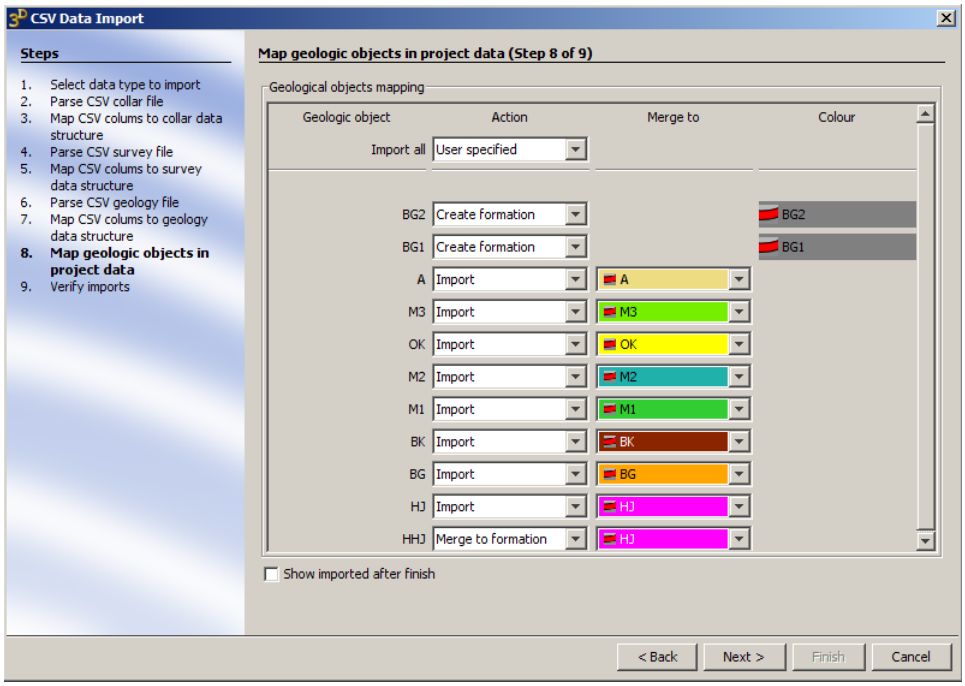
The image below is an example of the 'User specified' mapping option. Some imported lithologies do not match a formation within the 3D GeoModeller project.



The image below is an example of mapping option 'Create formation'. Some imported lithologies do not match a formation within the 3D GeoModeller project (Fig 2) and the user has decided to select the 'Create formation' option. Unmatched lithology codes will be used to create new formations on import. The global drop down selection remains set to User specified.



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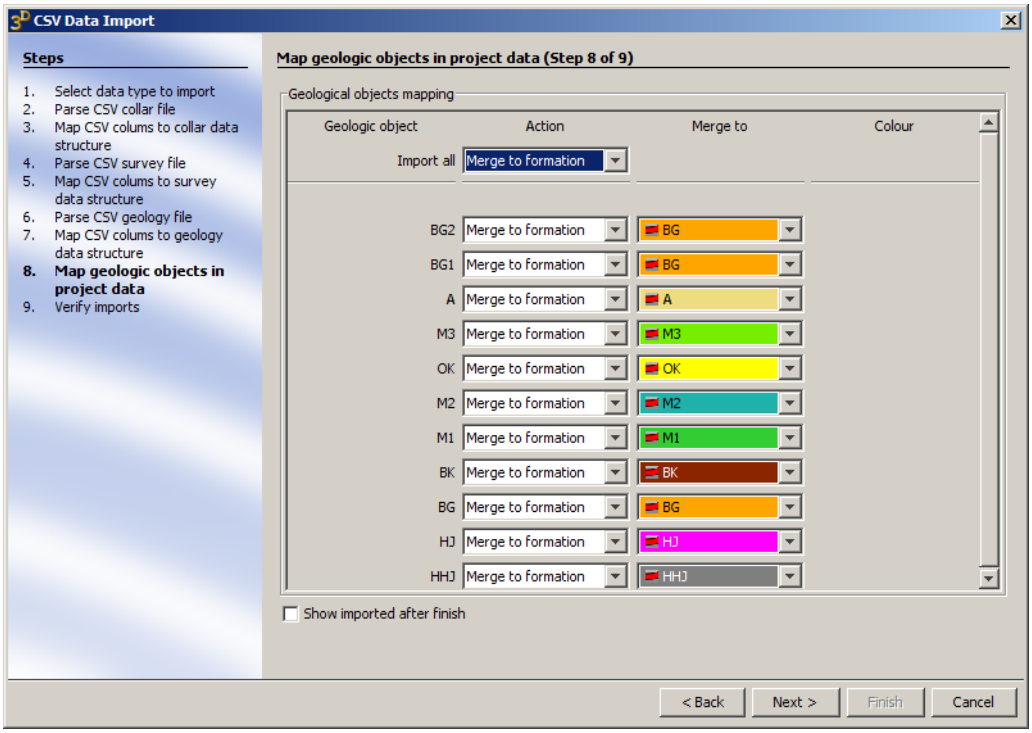
The image below is an example of mapping option 'Merge formation'. Some imported lithologies do not match a formation within the 3D GeoModeller project (Fig 2) and the user has decided to select the 'Merge formation' option. Where possible unmatched lithologies will be matched to formation names containing the same leading characters. The option 'Merge formation' is now selected as all lithologies have been matched to project formations.



When the user selects **Next >** in the **Map Geologic Objects** window an initial view of the validation results will be displayed. The following figure is a synthetic example. It shows a variety of validation failures demonstrating how the results are presented to the user.

Note that only the first validation error encountered for any single drillhole is reported to the user. If multiple errors exist for any single drillhole then it will be necessary to make more than one pass through the validation process before they are diagnosed and can be fixed.

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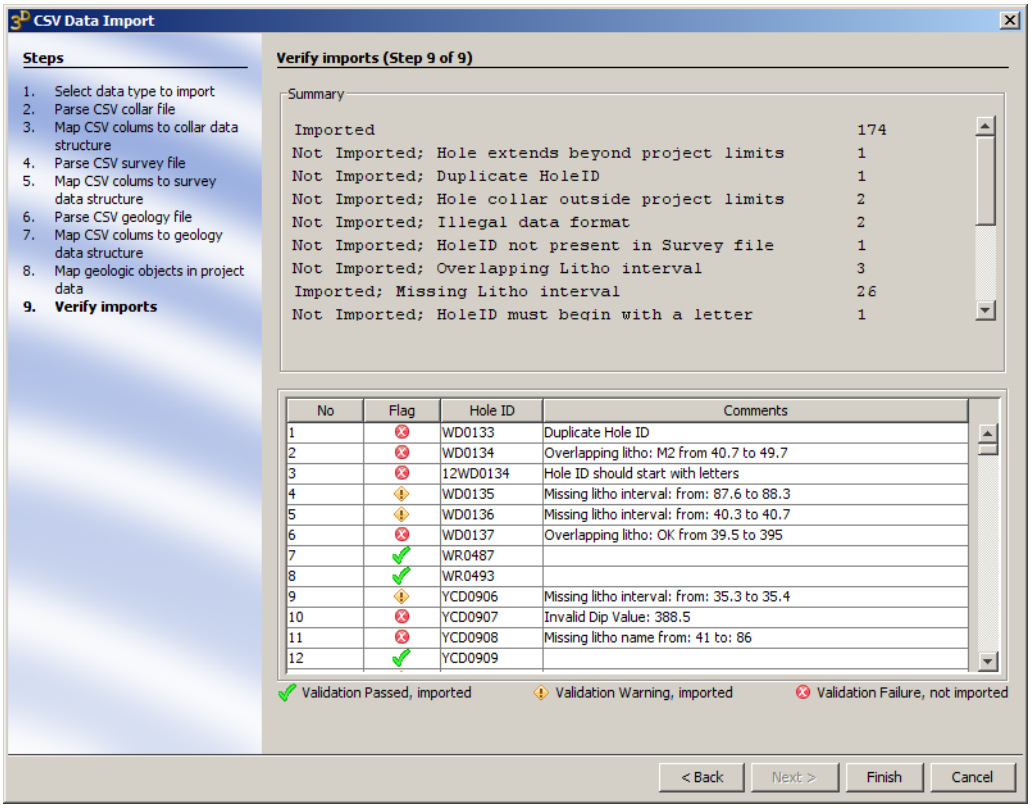
The sequence of validation steps proceeds in a defined order of order of severity. See Validation rules for drillholes (3 Files CSV format).


CSV Data Import
Steps
1. Select data type to import
2. Parse CSV collar file
3. Map CSV colums to collar data structure
4. Parse CSV survey file
5. Map CSV colums to survey data structure
6. Parse CSV geology file
7. Map CSV colums to geology data structure
8. Map geologic objects in project data
9. Verify imports
Verify imports (Step 9 of 9)
Summary
Imported 174
Not Imported; Hole extends beyond project limits 1
Not Imported; Duplicate HoleID 1
Not Imported; Hole collar outside project limits 2
Not Imported; Illegal data format 2
Not Imported; HoleID not present in Survey file 1
Not Imported; Overlapping Litho interval 3
Imported; Missing Litho interval 26
Not Imported; HoleID must begin with a letter 1
No Flag Hole ID Comments
1 WD0133 Duplicate Hole ID
2 WD0134 Overlapping litho: M2 from 40.7 to 49.7
3 12WD0134 Hole ID should start with letters
4 WD0135 Missing litho interval: from: 87.6 to 88.3
5 WD0136 Missing litho interval: from: 40.3 to 40.7
6 WD0137 Overlapping litho: OK from 39.5 to 395
7 WR0487
8 WR0493
9 YCD0906 Missing litho interval: from: 35.3 to 35.4
10 YCD0907 Invalid Dip Value: 388.5
11 YCD0908 Missing litho name from: 41 to: 86
12 YCD0909
Validation Passed, imported
Validation Warning, imported
Validation Failure, not imported
< Back
Next >
Finish
Cancel

The **Verify Imports (Step 9 of 9)** shown above presents the detailed results of validation. The user can choose one of the following options:

- **Finish** and import all holes except those marked with the symbol indicating **Validation Failure, not imported**
- Choose **Cancel** and rectify the validation problems reported in the CSV files.
- Edit the problems in the CSV files. Choose **< Back** and go back to the point where the corrected file can be reloaded. Step forward. Check the new validation results and then choose **Finish**.

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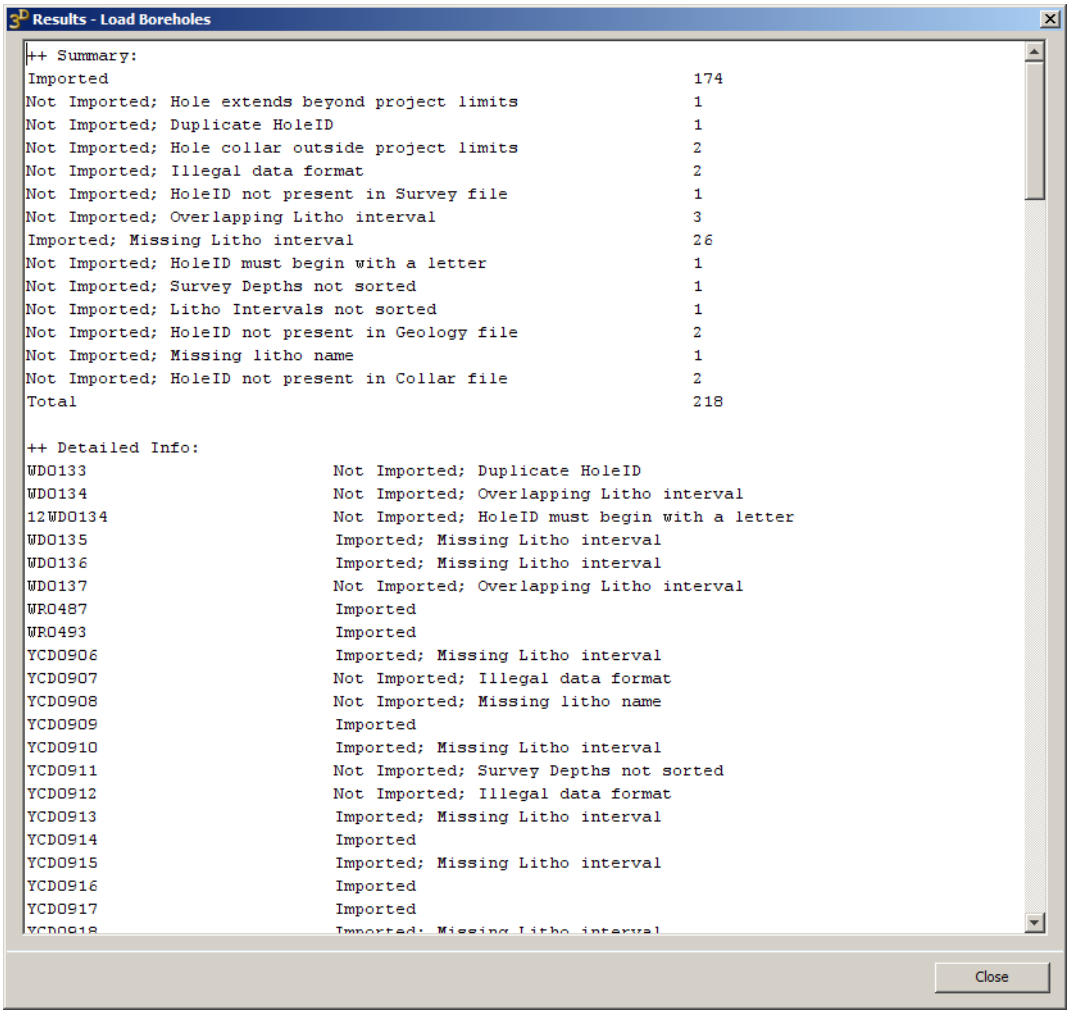
When the user chooses **Finish** as described above, a validation summary window **Results – Load Drillholes** opens.


Results - Load Boreholes
++ Summary:
Imported 174
Not Imported; Hole extends beyond project limits 1
Not Imported; Duplicate HoleID 1
Not Imported; Hole collar outside project limits 2
Not Imported; Illegal data format 2
Not Imported; HoleID not present in Survey file 1
Not Imported; Overlapping Litho interval 3
Imported; Missing Litho interval 26
Not Imported; HoleID must begin with a letter 1
Not Imported; Survey Depths not sorted 1
Not Imported; Litho Intervals not sorted 1
Not Imported; HoleID not present in Geology file 2
Not Imported; Missing litho name 1
Not Imported; HoleID not present in Collar file 2
Total 218
++ Detailed Info:
WDO133 Not Imported; Duplicate HoleID
WDO134 Not Imported; Overlapping Litho interval
12WDO134 Not Imported; HoleID must begin with a letter
WDO135 Imported; Missing Litho interval
WDO136 Imported; Missing Litho interval
WDO137 Not Imported; Overlapping Litho interval
WRO487 Imported
WRO493 Imported
YCD0906 Imported; Missing Litho interval
YCD0907 Not Imported; Illegal data format
YCD0908 Not Imported; Missing litho name
YCD0909 Imported
YCD0910 Imported; Missing Litho interval
YCD0911 Not Imported; Survey Depths not sorted
YCD0912 Not Imported; Illegal data format
YCD0913 Imported; Missing Litho interval
YCD0914 Imported
YCD0915 Imported; Missing Litho interval
YCD0916 Imported
YCD0917 Imported
Close

You can Copy/Paste from the above window into a document to save the validation summary. The results are not currently written to a file.

Validation rules for drillholes (3 Files CSV format)

Parent topic: **Importing drillholes and drillhole geophysical logs and assays**

- Drill Hole Collar location must be inside the project area.
  - Any Hole outside the project area will be reported to the user in the Validation report.
  - The hole will not be imported.
- Normally a Drill Hole Collar RL will be very close to the terrain surface (except in an underground mining situation); characteristically however the terrain model is often less accurate than the Drill Hole collar survey. Currently no test is done to warn the user of any elevation mismatches.
- Hole names must begin with the characters a-z, A-Z. Drill holes with names commencing with illegal characters (numbers) will be reported to the user in the Validation report and will not be imported if the user chooses to continue.
- Duplicate Hole names in any of the import files will be reported to the user in the Validation report. Duplicate holes will not be imported.

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- Drill Hole import files are tested to ensure that the survey and litho records for each are in Depth sorted order. Failure of this test will be reported to the user in the Validation report. Holes that fail this test will not be imported.
- In the multiple (3 file) case each Drill Hole name in the Collar file must have a matching Hole name in the Survey and Geology files.
  - If a Hole name in the Collar, Survey or Geology file does not occur in any of the other 3 files then the user will be warned in the Validation report.
  - A Hole in the Collar file without a matching survey or geology entry will not be imported.
  - Holes in the survey and/or geology files without a match in the Collar file will be reported to the user during validation and will be ignored if the user chooses to continue.*
- When a Final/Total Hole Depth field (EOH) is available in the collar file. It will be used to test the Depth and Depth_To fields in the Survey and Geology files to ensure these are always less than or equal to the Total Hole Depth.

  IF an EOH Depth is defined in the Collar file THEN

  Any Survey or Geology Interval which occurs beyond the EOH will be reported to the user in the Validation report.

  AND

  The Hole will not be imported if the user chooses to continue.

  ELSE

  IF there is no EOH depth available in the Collar file THEN

  The total hole depth will be the greater of the maximum survey depth and the maximum Depth_To.

  AND

  The hole will be imported

  Note: The Total Hole Depth field is not supported for import in 3D GeoModeller V1.3. This option will be supported in V2.0. The rule marked * above still applies in 3D GeoModeller V1.3.
- Duplicate survey depths or geology [From – To] intervals for any Hole will be reported to the user in the Validation report. If the duplicate records match for all fields then one record will be imported if the user chooses to continue otherwise the hole will not be imported. (All fields do not match.)
- Validation of the survey file detects Dips or Azimuths (dip directions) that are outside the possible numeric range.

  Abs (Dip) > 90 OR NAN

  Azimuth < 0 OR > 360 OR NAN

  Holes that fail this test will not be imported

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- Overlapping intervals [From – To] are not permitted in the geology file (3 file case) and will be reported to the user in the Validation report. Holes that fail this test will not be imported.

  Example

From	To	Litho	
0	5.3	A	
5.3	75	Gd	Error—missing decimal point creates overlapping interval
7.5	10.0	St	
10.0	15.1	Ss	

- Geology From – To intervals must be continuous down each hole (3 file case). The last To must equal the next From. Failures will be reported to the user as a "Missing interval" in the Validation report. Holes that fail this test will be imported if the user chooses to continue.

  Example

From	To	Litho	
0	5.3	A	
5.3	7.5	Gd	
			Error—missing interval from 7.5 to 10
10.0	15.1	Ss	

- Geology intervals must contain a litho or formation descriptor. Any Null or blank litho or formation descriptors will be reported to the user in the Validation report. Holes that fail this test will not be imported.

  Example

```
Holename,From,To,Litho,Colour
0.0,5.3,A,Bn
5.3,7.5,Gd,Pk
7.5,10,,Gy  # >> ERROR—MISSING DESCRIPTOR
10.0,15.1,Ss,Rd
```

- Geology From – To (3 hole case) intervals with zero thickness are not permitted. From == To OR consecutive Tos are equal (BRGM ASCII case). Failures will be reported to the user in the Validation report. Holes that fail this test will not be imported. A workaround for this problem is to set the zero length intervals to a small thickness (0.1m).

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Importing a single BRGM ASCII file

Parent topic: Importing drillholes and drillhole geophysical logs and assays

See File Formats—Drillholes for details.

Importing a binary GDM data record (BRGM software format)

Parent topic: Importing drillholes and drillhole geophysical logs and assays

You can import drillholes from a GDM project database. A drillhole is represented in 3D GeoModeller as a section which consists of a succession of segments, each one corresponding to an interval of geology intersected in the drillhole.

The geology formations intersected in the drillhole must be identified by a code indicating the base-name of the drillhole. When loading the drillhole, 3D GeoModeller adds the data to the list of the known geology data for the project.

If the names of geology formations (for the drillhole data) are not identical to those already defined in the project, but the formations are the same, use the Merge function available in the **Create (or Edit) geology data** dialog box (see Create (or Edit) Geology Data dialog box).

To load a drillhole:

- Choose **Open** and specify the GDM project database containing the drillhole to load
- Select the name of the drillhole in the list
- Select the field containing the geological formations (field “code” in the GDM database)
- Input a name for the section into which the drillhole will be loaded
- Input a direction for this section, and a width
- Choose **OK**.

Note

- The drillhole cannot be loaded unless co-ordinates have been assigned for the drillhole collar and the geology intervals.

Importing an XML file, formatted according to the GeoSciML standard

Parent topic: Importing drillholes and drillhole geophysical logs and assays

You can load drillholes directly from a GeoSciML xml file by navigating and selecting the GeoSciML file with the file selector. The drillhole will be loaded directly into the current 3D GeoModeller project.

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Importing drillhole geophysical logs and assays into existing drillholes

Parent topic: Importing drillholes and drillhole geophysical logs and assays

Drillhole geophysical logs and assays recorded in standard holename, depth from/to format with associated numeric field values can be imported from TXT, TAB or CSV format ascii files, to existing drillholes within the current 3D GeoModeller. The holenames must match exactly for the import to succeed.

ie HOLEID,FROM,TO,MagSusc1,MagSusc2,MagSusc3,MagAVG

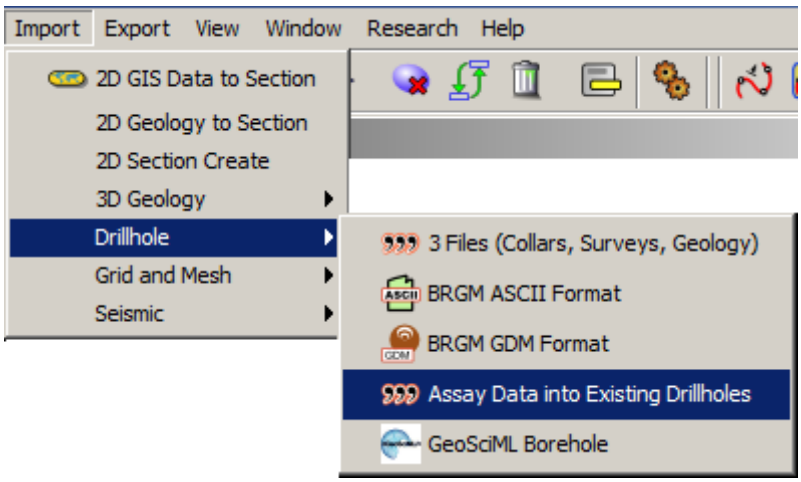
DH00001,0.0,1.0,11.80,11.10,10.80,11.23

DH00001,1.0,2.0,12.60,1.87,9.97,8.15

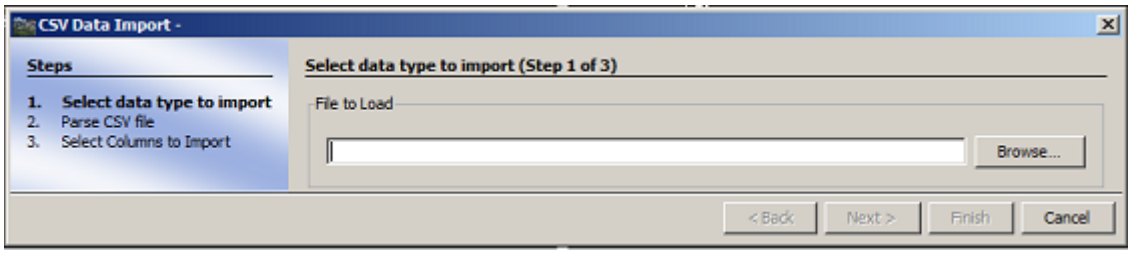
DH00001,2.0,3.0,8.81,10.20,7.22,8.74

To import drillhole numeric data:

- RightClick on **Assay Data into Existing Boreholes**



- **Step1. Select data type to import**
  - Browse and select the ASCII file to load then click **Next >**



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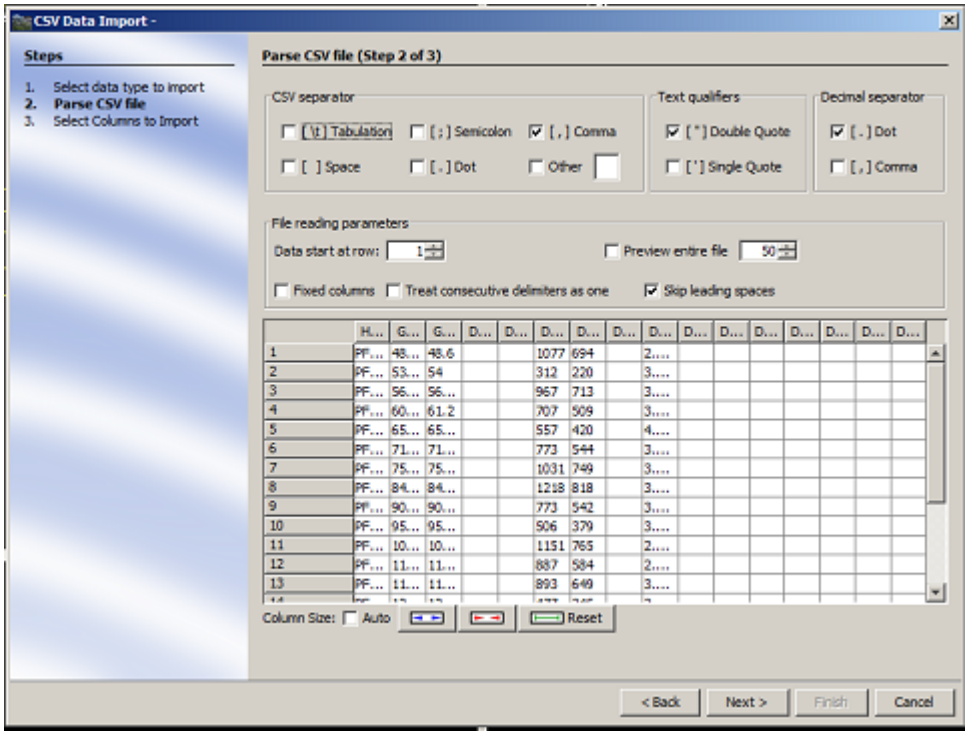
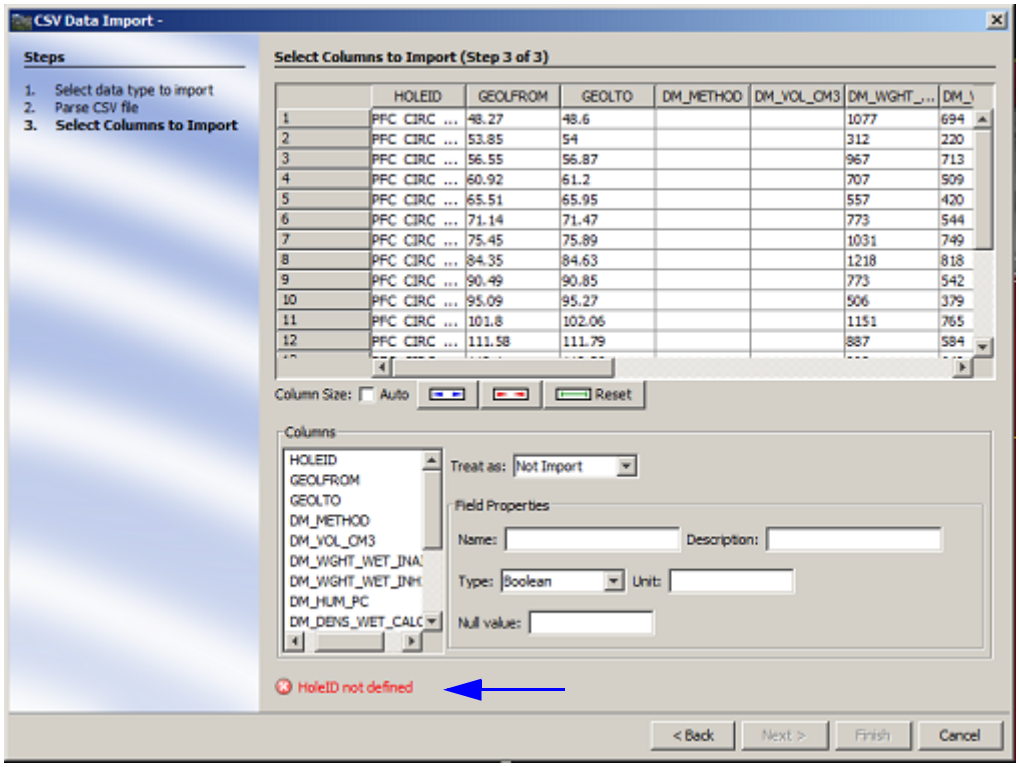
- **Step2. Parse CSV file -**
  - Select the correct **CSV separator** and the **Data start at row** parameter



  - Choose any other CSV Data Import wizard options required to correctly parse the incoming file and click **Next >**



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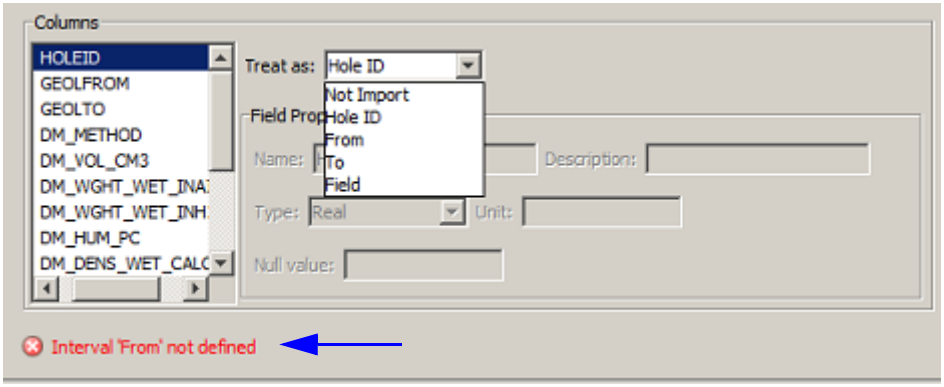
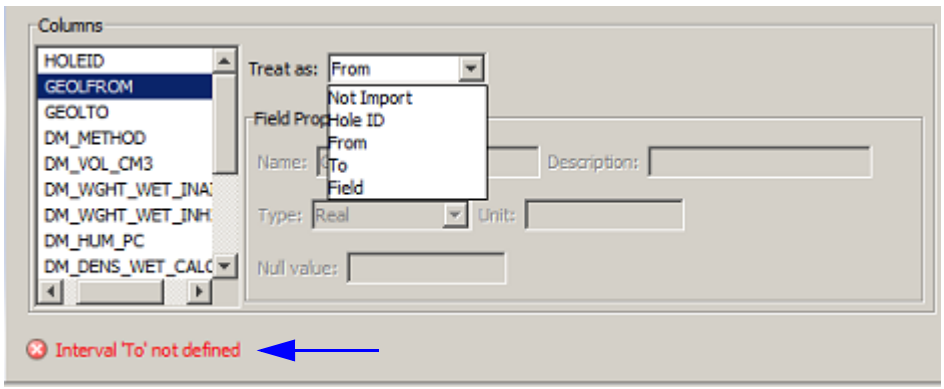
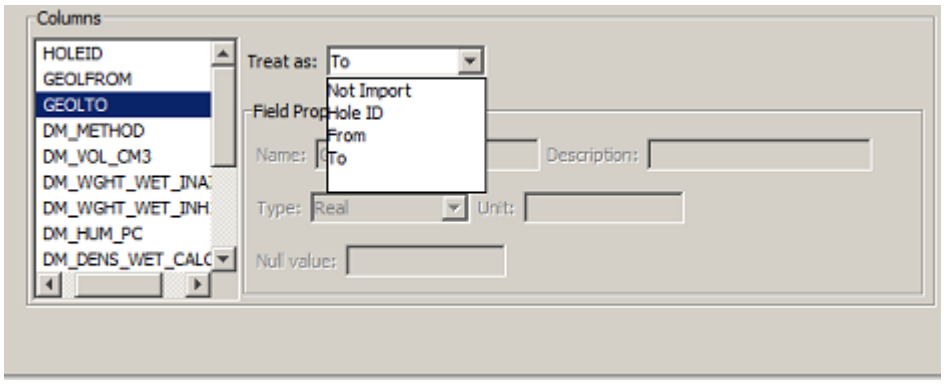
- **Step3. Select Columns to Import**
  - Select HOLEID in the **Columns** list then select **Hole ID** from the **Treat as:** drop down list; the red highlight prompt (blue arrow) will dissolve and a new red highlight will warn that the *Interval "From" column not defined*



  - Select GEOLFROM in the **Columns** list then select **From** in the **Treat as:** drop down list; the red highlight prompt (blue arrow) will dissolve and a new red highlight will warn that the *Interval "To" column not defined*



  - Select GEOLFROM in the **Columns** list then select **To** in the **Treat as:** drop down list;



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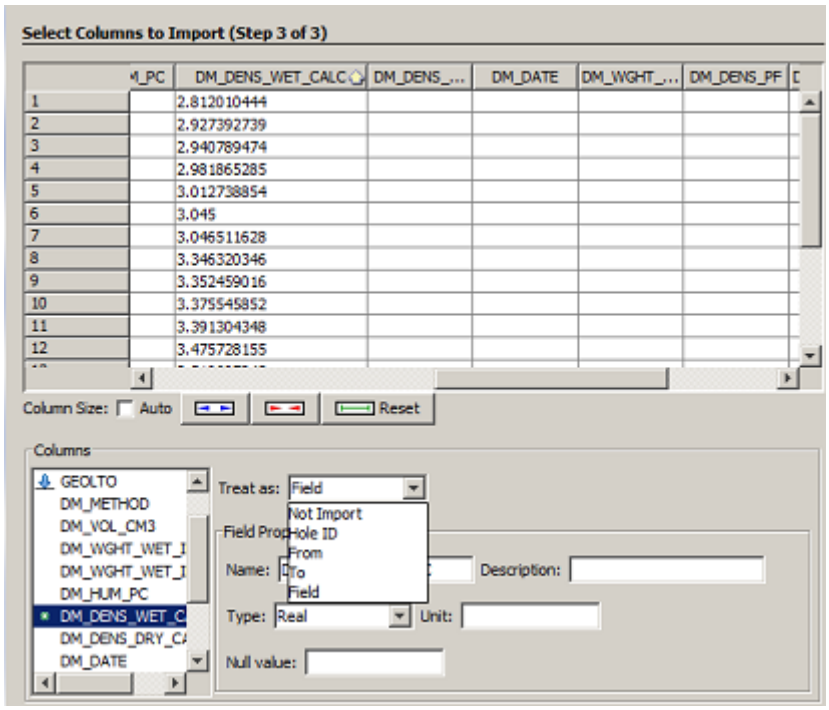
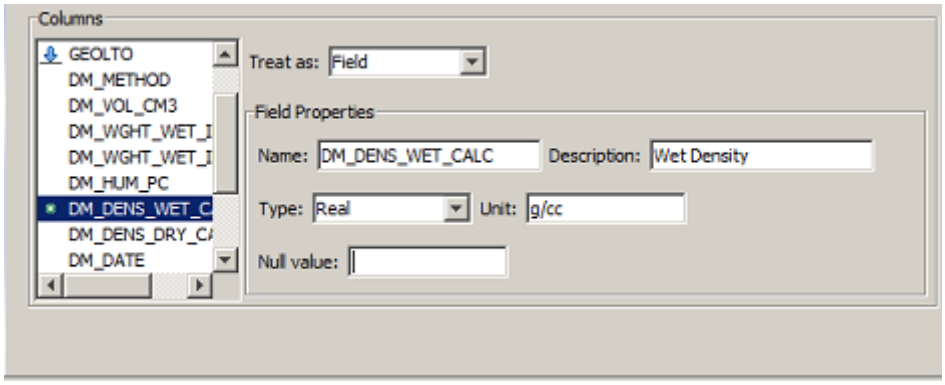
- Now choose the numeric fields to import; move slider left to expose numeric columns in the upper pane and Click on DM_DENS_WET_CALC in the **Columns** list



- Choose **Field** in the **Treat as:** drop down list; and complete the **Field Properties** pane dialog boxes



- Edit the **Name:** of imported field to be as brief as possible ie ***Density***
- Enter a **Description:** of imported field ie ***Wet Density***
- Choose a field datatype (**Type:**) from the drop down list; be careful not to truncate your data.
- Enter the data **Units:** ie g/cc, kg/m^3
- Enter the **Null value:** for undefined/unmeasured intervals ie -999; leave blank if represented by an empty string in the csv file ie ,,

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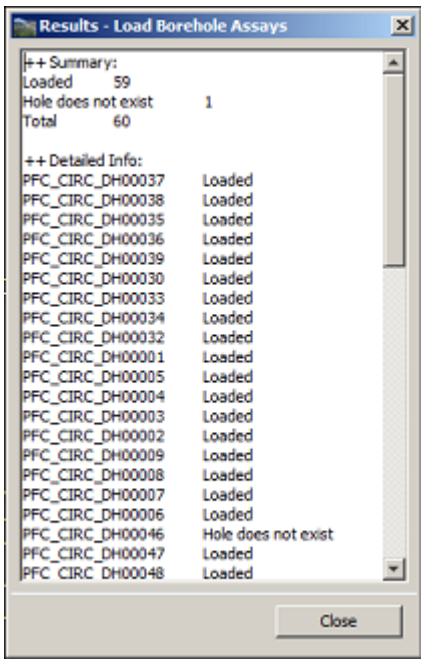
- Click **Finish** at the bottom of the main dialog to commence the Import. On completion a Results report dialog will appear listing the holes for which the numeric data was imported and any problems encountered ie holes with numeric data which do not exist in the current project.



- Click Close to finish.

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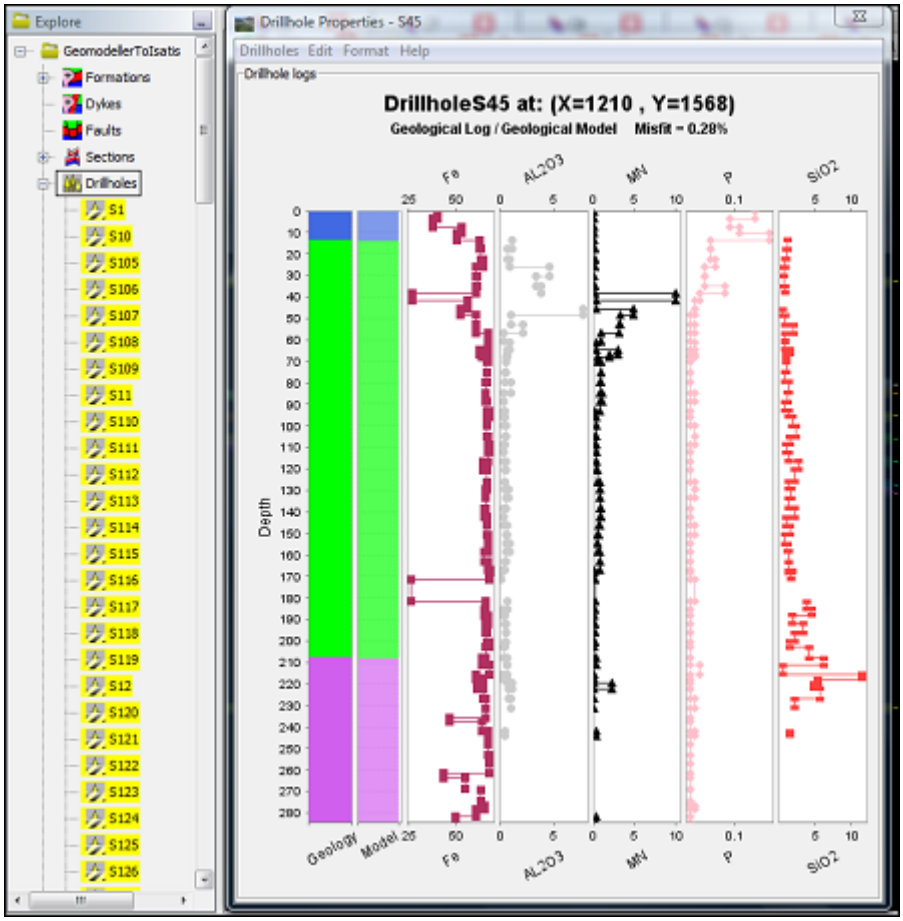
- The numeric data can be visualised in profile as part of the drillhole log via the **Drillholes** branch in the **Explore** tree. Double clicking on an individual drillhole in the tree or RightClicking and selecting Properties will bring up the drillhole log view.



Drillholes are listed in the Project **Explore** tree under **Drillholes**. Drillholes also appear under **Formations, Dykes** and **Faults** in a Drillhole sub branch under each unit, if the drill hole contains an interval from that formation, dyke or fault.

See File Formats—Drillholes for further details on import formats.

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Geoscientific Principles and Underpinnings

Parent topic: 3D GeoModeller Reference

In this section:

- Inference of the covariance of the potential field
- Radial Basis Functions

3D GeoModeller draws on many aspects of Mathematics, Physics, Material Science, Geology, Geostatistics and Geophysics.

Perhaps the most fundamental improvement follows from observing how geological fabrics behave. This is a natural extension to the displine of geostatistics. Initially, numerical variabilities such as the grade of a gold vein, has driven geostatistical thinking over more than 30 years. It was inevitable then, that the form and shapes of naturally occurring geological bodies would also come under scrutiny. This work was conducted in France over several years (Chilès et.al. 2004).

The major outcome includes an insight into how the relationships between structural geology observations and contacts can be approximated by fitting a cubic function to the experimental variogram for the contacts and a linked differentiated cubic function to the parallel and perpendicular components of the dip vectors. Potential Field theory is suitable as it has close properties to the desired model.

Inference of the covariance of the potential field

Parent topic: Geoscientific Principles and Underpinnings

In usual geostatistical applications, the covariance or variogram of the variable under study is modelled from the sample variogram of the data. When modeling geology, we have no measurement of the potential T(x), and the potential increments used for the interpolation cannot be used for the inference of K since they all have a zero value. In its first implementation, the algorithm was used heuristically with a covariance model arbitrarily chosen by the user. That choice was more or less rationalised according to the following considerations:

- At the scale considered, geological interfaces are smooth rather than fractal surfaces. This implies that the covariance is twice differentiable. A cubic model is a good compromise among the various possible models, because it has the necessary regularity at the origin and has a scale parameter that can accommodate various situations.
- The scale parameter a and sill C of the covariance K(h) determine the sill of the variogram of the partial derivatives: it is equal to

$$\frac{14C}{a^2}$$

  in the case of an isotropic cubic covariance. When there is no drift and the geological body is isotropic (for example, a granitic intrusion), the unit gradient vector can have any direction so that its variance is equal to one. The variance of each partial derivative is then equal to one third.
- A consistent choice for C once the scale parameter a is chosen, is therefore .

$$\frac{a^2}{42}$$

  That value is an upper bound for C when the potential field has a drift. This is because the mean of the potential gradient is not equal to zero and its variance is less than one (its quadratic mean is zero by definition).
- Sensible measurement variances can also be defined (nugget effects).

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The use of a heuristic model, however, implies two limitations:

- The choice is usually not the best one.
- (More importantly) This precludes any evaluation of the magnitude of the interpolation error.

A means to infer the covariance is thus a core issue of that approach. Since K cannot be inferred from the potential increments, it is inferred is from the gradient data. This is possible because the covariances of the partial derivatives can be derived from assuming a potential field.

In the case of an isotropic covariance K(h), which for simplicity will be denoted K(r) as a function of r = | |h| |, the covariance of, say, $\partial T(x) / \partial u$ and $\partial T(x+h)/\partial u$ is

$-K''(||h||)$ when h is parallel to the u axis,

$-K(||h||) / ||h||$ when h is orthogonal to the u axis.

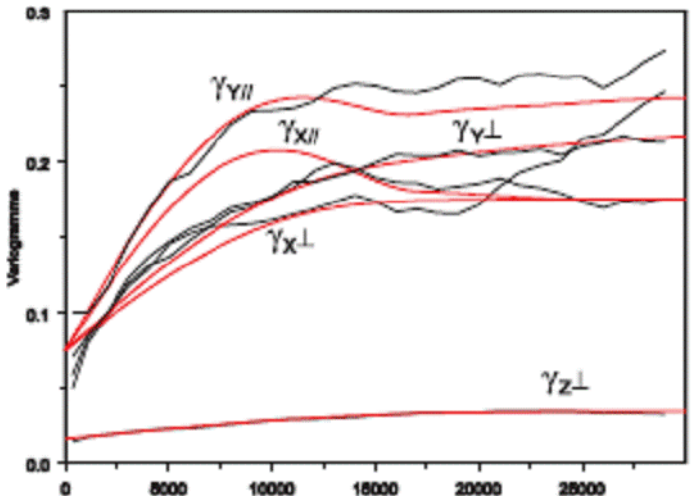
Isotropy vs anisotropy

The assumption of an isotropic covariance model is the standard starting position. It can become too restrictive and with V1.3 3D GeoModeller, options for anisotropy are more available. This allows you to model more reliably, thinner bodies such as dykes.

In practice the covariance K(h) is the sum of several cubic components Kp(h), each one possibly displaying a zonal or geometric anisotropy. With the initial formulation of this capability, the main anisotropy axes u, v, w, are common to all the components. Current development work allows for each geological series to have its own definition of anisotropy.

Using the formulae for the selected model the covariance parameters of K (nugget effect, scale parameter of each covariance component in the three main directions, sill of each component) are chosen so as to lead to a satisfactory global fit of the directional sample variograms of the three components of the gradient.

Figure 11



Example of fitting of the covariance of the potential field from the sample variograms of the partial derivatives of the potential field. Limousin dataset, Massif Central, France. (Aug, 2004).

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Figure 11 shows an example of such a fitting. 1485 structural data was sampled in an area of about 70 × 70 km^2 in the Limousin (Massif Central, France). The main (u, v, w) coordinates here coincide with the geographical (x, y, z) coordinates. Since the structural data is all located on the topographic surface, the variograms have been computed in the horizontal plane only. Note that the sill of the variogram of the vertical component is much lower than that of the horizontal components. This is due to the fact that the layers are subhorizontal so that the vertical component of the gradient displays limited variations around its non-zero mean. The model K includes three components, the second of which only depends on the horizontal component of h and the third one on the N–S component (zonal anisotropies).

Stationarity Property

An important assumption made is that any trend in the spatial variability of the geology can be removed or detrended. The aim in detrending the "geology", is to achieve a state where any remaining variability is essentially random and the "geology" is stationary.

This allows cokriging to be performed in the framework of a random function model. Formally, the mathematical function used to model geology T(x), is assumed to be a random function with a polynomial drift, and a stationary covariance K(h).

Detrending geology

Since the vertical usually plays a special role, the degree of the polynomial drift can be higher vertically than horizontally and the covariance can be anisotropic.

Not all geology is layer cake. An intrusive geological body that has the shape of an ellipsoid, can be detrended assuming a quadratic drift—use ten coefficients for the drift function with degree less than or equal to two.

So, in general, a three dimensional quadratic drift function is the current practise.

In theory, other detrending methods like sinusoidal terms could be used, but in usual applications geology is not regular enough for that.

It is also important to note that as no attempt is being made to follow the genesis of the geology, there is no need to try and "mass balance on a section by section basis". We are modeling what is observed, not simulating a folding and faulting progression.

Interpolating geology using the potential field method

In summary, the potential field method defines a geological interface as an implicit surface, namely a particular isosurface of a scalar field defined in the 3D space—the potential field. The 3D interpolation of that potential field, based on universal cokriging, provides isosurfaces that honour all the data. Since no data measures the potential field itself, its covariance cannot be inferred directly. However, the covariance can be determined from the structural data, which makes it possible to associate sensible cokriging standard deviations to potential field estimates and to translate them into uncertainties of the 3Dmodel.

The implementation of joint structural geology and contacts interpolation based upon experimentally derived methods, is a unique breakthrough in turning geology mapping and interpretation into a quantitative science. It is a fallacy to now claim there is no basis for how one should interpolate geology, so any methods are equally adaptable.

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Radial Basis Functions

Parent topic: Geoscientific Principles and Underpinnings

Universal kriging implies that all observations have an influence on every part of the model, no matter how far away an observation may be. However, it is now recognized that the majority of the influence is from those observations that are local to that part of your model. This turns out to be a local radial basis interpolator, using classical geostatistics.

A very similar outcome can also be arrived at with alternate mathematical thinking. One candidate is the use of the biharmonic equation and thin plate theory from engineering science, to interpolate the geology. This can be easily formuated as a radial basis function. In this case, there is no attempt to honour observed characteristics of how geology bodies should be modeled, just the condition that all observed contacts are honoured. Where there are many observations of geological contacts, say in an in-mine context with lots of bore holes, this method will produce a satisfactory prediction of each geological contact surface.

Surface vs Volume

The important point to make here is that one should interpolate volumes rather than surfaces, and this is central to the 3D GeoModeller potential field method. Thin plate surface interpolations do not naturally have this property. As the number of observations become sparser, the breakdown in being able to produce realistic geological bodies will become very pronounced for the thin plate spline methods. There is no natural constraint to have Top and Bottom surfaces for a unit follow the same trends, if using surface splining.

Not coincidently, well behaved geological volumes are also important for the geophysical modeling and inversion aspects of 3D GeoModeller. Both the total mass and total magnetization of a unit is inherently tied to the volume of the body. It is now more generally recognized that it is the volume of the unit, not just individual bounding surfaces, that is important in producing believable 3D geology models. In later sections of this manual, many references to characterizing allowable volume changes while inversion is being pursued, will be made.

Faults

Several methods are used to handle faults. If faults delimit blocks and the geology is not correlated from one block to the other, it obviously suffices to process each block separately. These are termed “TERRAIN” faults.

For most other cases, the method used in 3D GeoModeller is a transposition to 3D potential fields of the method proposed by Maréchal (1984). This handles faults in the 2D interpolation of the elevation of interfaces, where faults are entered as external drift functions. This method requires knowledge of the fault plane and also its zones of influence.

For the case where a normal fault intersects the whole study zone, the geology is divided into two sub zones D and D'. This fault induces a discontinuity of the potential field, whose amplitude is not known. Cokriging can accommodate that discontinuity whatever its amplitude by introducing a drift function complementing the L polynomial drift or detrending functions above, for example:

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If the polynomial drift functions include the first coefficient f 1(x) = x (first coordinate)

$$fL + 1(x) = 1D(x)$$

due to the presence of a linear trend of the potential field, and we have good reasons to suspect not only a discontinuity but also a change of slope of the drift when crossing the fault, it is advisable to also introduce an additional drift function such as:

A finite fault can be modeled with a drift function with a bounded support, and whose

$$fL + 2(x) = x1D(x)$$

value vanishes on the support boundaries; inside that support, the function takes on positive values on one side of the fault plane, with a maximum at the centre of the fault, and negative values on the other side.

The fault plane is unlikely to be a planar surface. It is often only known by some points on its surface and unit vectors orthogonal to it. Its geometry can thus be modeled by a potential field too.

Currently, faults are not honored in inversion.

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Parent topic: 3D GeoModeller Reference

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The authors of this manual are Philippe Calcagno, Gabriel Courrioux, Antonio Guillen, Phil McInerney, David Stephensen.

The original English translation was by Phil McInerney

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